THE
Malayan Agricultural Journal
APRIL, 1950

EDITORIAL

Peat Soils in Malaya.

During recent years the peat soils of Malaya have come into increasing prominence. Practically the whole of the Malayan pineapple industry, which before the war formed Malaya's third largest export, draws its fruit from these soils. In Johore, the peat soils have taken the place of the quartzite soils which were heavily exploited before being abandoned in 1938 and 1939. Again, two of the large padi schemes, namely Tanjong Karang and Trans-Perak, now in course of development, include large areas of peat.

From the article appearing in this issue of the Journal, it will be noted that the estimated area of approximately 1,000,000 acres of peat forms a considerable percentage of the total area of land in Malaya which can be considered as suitable for agricultural development. The method of formation and the depth of the peat in certain surveyed areas is also discussed. The depth of the overlying peat is an important factor in the development of these areas because, as yet, few of the plantation crops or padi have been cultivated on deep peat, and the behaviour of these deeper areas is largely unknown.

A method of chemical analysis which has been used for the examination of the peat from various areas is outlined and the results given. Malayan peat soils are developed almost entirely from forest trees, in contrast to those of the Fens of England and the Everglades of Florida which are developed from reeds and sedges. The latter are often cited as examples of areas where bumper crops are grown on peat, but the Malayan peats are very much poorer in plant nutrients. On the border of the Malayan peat areas the richer muck soils and organic clays are obtained, but the peat itself, in spite of its very high organic matter content, can only be regarded as a poor medium for crops.

The author gives an outline of some experiments in which padi was grown in pots of peat and these experiments indicate that padi will respond to fertilisers, especially nitrogen. On the other hand, it has been found that in certain countries, particularly New Zealand and Florida, minute amounts of such elements as copper have given spectacular results when applied to peat, but no such results have been obtained from the application of these elements to Malayan peats. This once again emphasises that the results for experiments on a soil of one area cannot be applied without modification to that of another, and this is again borne out by the fact that ramie is very successful on Florida peat but scarcely grows on the Malayan material.

This article, serving as an introduction to the study of these soils, emphasises the vast number of problems which are peculiar to them and the amount of research which will be necessary to find the best methods for their utilisation.

Natural Cross Pollination of Rice.

Since the war, padi selection work in Malaya has recommenced on a wide scale, and exact knowledge is required of the many factors affecting the efficiency of selection technique.

Padi flowers are normally self fertilizing, and selection of better strains by "ear to row" pure line selection is the usual method of improving the yield and quality of the padi crop.

It has always been known, however, that a small amount of cross-pollination occurs, and investigations were commenced before the war to determine the extent of this for estimation of its effects on the technique of pure line selection.

The details of the pre-war investigations have been lost, and this work, amongst many others, is now again in progress. The article herein discusses the problem, its implications, the method of investigations, and results and conclusions to-date.

Mud and Wattle Smoke-Houses for Rubber.

To enable an owner of a rubber smallholding to obtain the maximum cash return from his holding, it is essential that he himself smokes his rubber. It is improbable that air-dried sheet, even when most carefully prepared, will ever be bought at the price of No. 1 Rubber. The high cost of building materials however has made it difficult and, in some cases, impossible, for owners of the smaller rubber holdings to erect smoke-houses.

In this issue of the Journal, Mr. Davidson of the Rubber Research Institute of Malaya explains how cheap and durable smoke-houses are built in Ceylon, using mud and wattle as major materials.

All the materials used can be obtained at low cost in Malaya and in many cases will be of better quality than those available in Ceylon. Only experience in technique is at present lacking, and the Rubber Research Institute is taking steps to remedy this.

Rokam Masam (*Flacourtia inermis*)

A minor fruit tree of Indonesia and Ceylon, *Flacourtia inermis* was observed in Malaya as long ago as 1819, but is little known in the peninsula except for an area in the Balik Pulau district of Penang, and three trees at the Federal Experiment Station, Serdang, which have been grown from seed brought from Java in 1939.

The fruits are bright red berries and are used by the Malays for making pickle. Jam and jelly can also be made from the ripe fruit.

In this number of the Journal a comparison is given of the recorded yields of the trees growing in the kampong in Penang and those at the Federal Experiment Station, Serdang. The use of the fruit for making pickle and jelly is also described.

Original Articles.

PEAT FORMATIONS IN MALAYA

BY

J. K. COULTER,

Acting Senior Chemist (Soils).

Introduction.

Although the existence of peat formations under tropical conditions has long been recognised, tropical peats have received comparatively little detailed attention. This is not surprising in view of the fact that it is only comparatively recently that the study of peat as a medium for crops instead of, as hitherto, a fuel has been undertaken. From the point of view of its use as a fuel, the detailed study of peat formation and composition has a long history. Within recent years, however, as the better class mineral soils have been fully taken up, agriculturists have turned their attention to this widespread material.

Nowhere has this been more true than in Malaya, where a large part of the projected development of irrigation schemes for padi growing and the extension of pineapple cultivation will, of necessity, take place on peat.

Hitherto little development of padi growing on this type of soil has taken place as it was generally believed that peat, as such, would not grow padi. On the shallower areas, say to a depth of 3 ft., oil palms and rubber have been planted. These, although they have yielded fairly well, have suffered from lack of root-hold, and it is a common sight in rubber plantations to see the roots lying exposed on the surface. In the case of oil palms the trees often fall over, though they still continue to yield. Oil palms have, on occasions, been planted on areas of deeper peat, but it has frequently been found that sooner or later they fail. Some fruit trees, rooted entirely in deep peat, can be seen growing well. There are also areas with a long history of continuous pineapple cultivation and, again, areas where many types of vegetables can be grown successfully.

Occurrence of Peat Formations.

It is estimated that there are areas totalling approximately 1,000,000 acres in Malaya which are covered by peat. These occur mainly in Perak, Selangor and in western Johore. There are also smaller areas in eastern Johore, in Kelantan and in Trengganu. Most of these have accumulated under conditions of forest and are consequently termed woody or forest peats. The conditions which lead to their formation are due to permanent waterlogging in basin-shaped depressions. It is generally found that near the coast there is a belt of heavy coastal alluvium clay, behind which the peat is formed, becoming deeper as the distance from the coast increases. It then gets shallower towards the foothills of the main range. Apart from these large accumulations, often covering thousands of acres, small localised patches are found in inland areas where similar conditions occur.

This peat must not be considered to lie in a bed of even thickness, because the meanderings of the various rivers have built up what are known as *permatang*. These are sandy or clay belts of higher land which stretch throughout the peat. Their occurrence is due to the silt and sand brought down by the rivers and deposited during times of flood, thus resulting in banks or levees being gradually built up. The rivers have frequently changed their courses, leaving numerous *permatang* in these areas. They serve a useful purpose in that they can be used as land on which settlers can build houses and grow their crops. From the detailed contour map of a small area of peat at Chenderong Balai in Perak, can be seen the large variations in depth which take place within small distances.

Formation of Peat Soils.

It may seem surprising at first, that peat can accumulate in Malaya, where the high temperatures favour the destruction of organic matter. One condition of peat formation, namely an abundant water supply, is, however, present. All the water from the mountains comes down to the coast and augments the already heavy rainfall there. Frequent flooding takes place and the water is held in the low areas by the rising ground.

It is also generally recognised that for the continuation of bacterial and microfloral action, a good supply of bases (calcium, potassium etc.) is essential, otherwise this activity tends to be arrested by the acidity it engenders. Due to the intense weathering which has taken place and to the fact that most Malayan rocks are poor in bases, these waters are also low in bases; consequently it has been found that the peats are very low in CaO and K_2O. Malayan forest trees in general are also of low ash content.

Mohr (1) points out that peat formation occurs in Sumatra where conditions are similar to those found in Malaya, but only to a very slight extent in Java where there is an abundance of bases from the young volcanic rocks. On the other hand, peat has developed in the Everglades of Florida where the bed-rock is limestone.

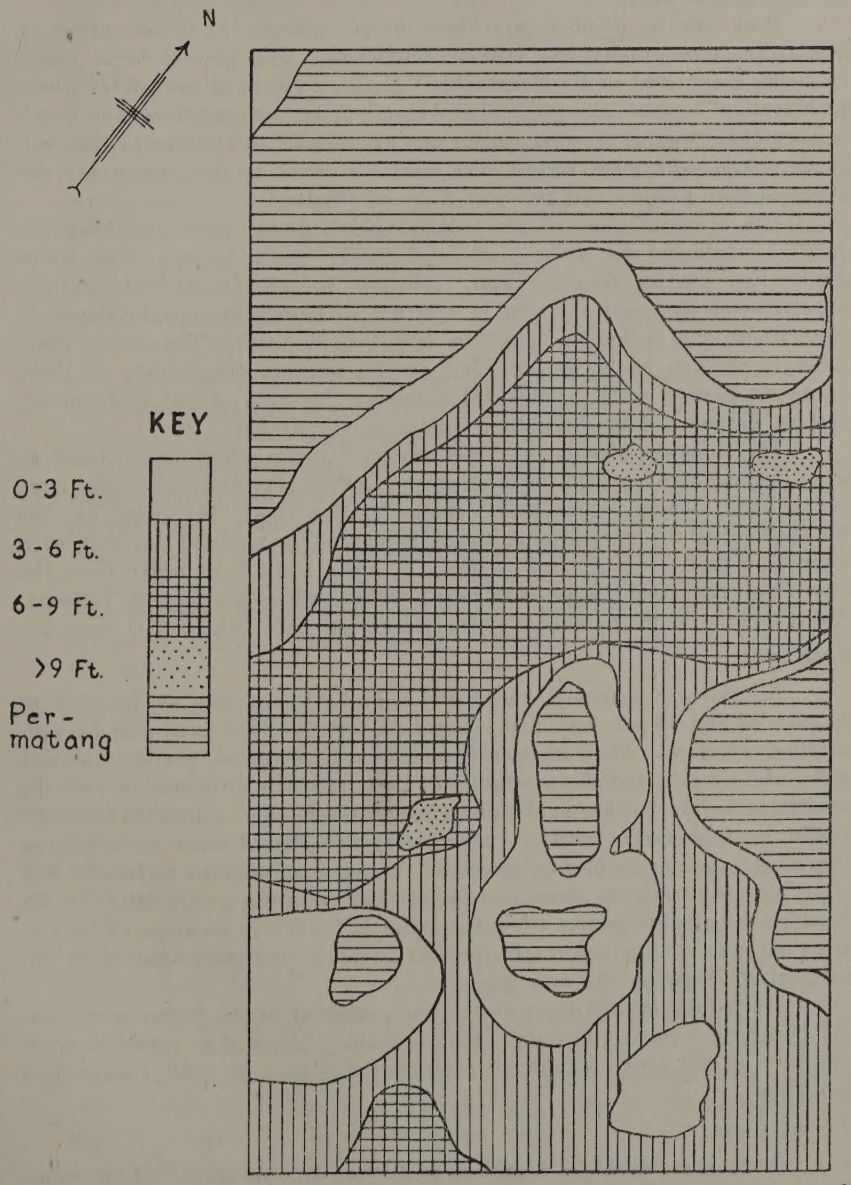
Classification of Peat.

At the 2nd International Congress of Soil Science held in Russia in 1930, Subcommission 6, which had been appointed to deal with peat, recommended that the term peat should be restricted to organic soils that are at least ½ metre in depth, 1 hectare in extent and with a content of mineral matter not exceeding 35 per cent. in peat (parent organic material) and 65 per cent. in muck (organic residue derived from peat acted on by soil forming processes) (2).

Peat occurring in temperate countries is generally of two kinds — upland and lowland peat. In Malaya a certain amount of upland peat occurs but it is of little interest from an agricultural point of view. In this country, for the sake of avoiding misunderstanding, the name 'bog soils' has been suggested to cover all the swamp deposits. It is then proposed to sub-divide this into peat and muck, as defined by the above Subcommission, and organic clay, that is, material having a loss of weight on ingnition of between 20 and 35 per cent.

CHENDERONG BALAI PEAT CONTOUR MAP.

Scale: 1 inch = 12 chains.



In Malaya, in the past, the term peat has been applied to a large number of organic deposits and has quite often been misleading. Frequently, material which reaches a few inches in depth and has a black appearance has been called 'peat'.

Peat can be divided into three broad groups (3) which differ in vegetation, stratigraphy and climate conditions. The first of these major divisions, designated as the "eutrophic" group, consists of peat areas where the layers are derived from predominant marsh and grass vegetation and which have an abundance of mineral matter and are neutral to alkaline in reaction. These provide the most fertile peat soils. Typical of this group are the Everglades of Florida and the peat Fens of England.

The second division is the "oligotrophic" group which, in temperate climates, includes the moss peats and woody peats derived from heath shrubs and conifer forests. They are low in mineral matter content, especially calcium, and are acid in reaction. These peats are developed in areas where the in-flowing water is very low in bases. The forest peats found in Malaya could be classified as the tropical counterpart of these temperate climate peats. Polak (4) describes the peats of eastern Sumatra, western Borneo and southern New Guinea as oligotrophic.

The third division is the "mesotrophic" group which is described as being intermediate between the other two. Griffith (11) describes a peat from Sawah Ring, Johore, which rather resembles this type. He states "It has the appearance of little altered forest litter and is reported to exist to a depth of 9 feet. Its pH is 5, namely of quite a different order from the other forest peats and it appears to have a rather higher base content. Information is lacking as to the nature of the vegetation under which it is formed".

Muck Soils.

As stated previously, these are soils having a loss on ignition of between 35 and 65 per cent. and which have been derived from peat by soil-forming processes. They are thus formed as a result of the partial oxidation of the surface peat and the admixture of these products of oxidation with the underlying layers. Since oxidation increases the mineral content, these soils should be reasonably fertile. In practice, the classification of a soil as 'muck' is based on its loss on ignition. Thus, a soil defined as 'muck' will result not only from the above process but also from the accumulation of silt amongst the organic matter when the latter is formed in an area fed by silt-laden waters. Consequently the present method of classification does not differentiate between the two types.

Muck soils mostly occur around the periphery of the deeper peat areas and generally form fertile soils. It is probable that in most areas of muck soil, both of the above mentioned processes have been at work during their formation.

Organic Clays.

These clays could be described as a "less organic stage" of the muck soils and in fact muck soils and organic clay often merge indistinguishably into one another.

The differentiation of the 'bog' soils into peat, mucks and organic clays in the field, especially if wet, is by no means easy. Often it has been found that areas described as consisting of peat have in fact consisted of muck soils or organic clays.

Characteristics of Malayan Peat.

Depth.

Malayan peat, as mentioned above, normally lies in depressions in the clay alluvium, the clay at the edges gradually merging into the muck, and this finally merges into peat which deepens as one proceeds towards the centre of the deposit. That these deposits can reach great depths was shown by borings carried out by the Department of Mines when prospecting in the Kuala Selangor area. Depths exceeding 18 ft. were encountered (6). In a detailed survey carried out at the Federal Experiment Station, Chenderong Balai, Perak, measurements showed a maximum depth of 10 ft.

The question of the depth of the peat is of importance in areas which are under consideration for development. In some quarters the view is held that these areas can best be utilised by disposing of the peat as quickly as possible. Where the peat is only 1 to 2 ft. in depth, its destruction would be a relatively quick and easy matter, and by mixing the shallow layer of peat with the underlying clay a rich soil should be obtained. Where, however, the peat reaches several feet in depth, the problem of disposal becomes much more difficult, as it must be borne in mind that the peat will disappear by oxidation only under aerobic conditions. In padi areas such conditions exist only during a short period of the year. Furthermore it has not yet been proved that it would be in the best interests of land utilisation to destroy the peat.

Morphological Characteristics.

The forest peats of Malaya, of which those occurring in the Telok Forest Reserve, Selangor, and at Chenderong Balai, Perak, are examples, are usually blackish-brown to reddish-brown in colour. When wet they form a plastic mass and when dry are light and fibrous in character. There are numerous woody fragments and, in the lower horizons, large roots and trunks often occur. Although these retain, to a large extent, their original structure they have suffered decomposition to varying degrees and sometimes break up readily in the hand. Portions of wood can be found which have suffered scarcely any decay and which are very tough and strong. The occurrence of timber in peat presents a formidable problem when mechanical cultivation is attempted, as up to 50 per cent. of the peat may consist of timber in varying stages of decay. The large timbers can, of course, be removed but the difficulty of drainage may arise, as the remaining timbers provide passages for the escape of the water.

This forest peat shrinks considerably on drying and the dry material is wetted again with difficulty and does not swell to the extent of its original volume.

Below the peat there is a milk-chocolate-brown clay which frequently smells of H_2S and rapidly darkens to a blue-black colour on exposure to the air.

In order to investigate the nature of the peat occurring at depth, several pits were dug in the Test Plot at the Federal Experiment Station, Chenderong Balai, and at Jalan Kebun in the Telok Forest Reserve. The profile pit at Jalan Kebun (Pit 1) may be taken as an example of what can be seen in one of these pits. This pit was dug to a depth of 6 ft., deeper penetration being impossible owing to the inrush of water. By pushing a notched stick into the soil at the bottom of the pit it was found that there was a further 2 ft. of peat, thus giving a total depth of 8 ft. The following is the description of the profile in this pit:—

0 to 3 ins. A black amorphous material with a granular structure and containing a few small fragments of wood.

3 to 12 ins. In this layer, the beginning of the raw unoxidised peat was in evidence, the colour changing from almost black to a dark coffee-brown colour. Larger pieces of wood were found.

12 to 24 ins. A reddish-brown fibrous material. Large chunks of timber were present. Some of these were almost completely decayed while others were well preserved.

24 to 36 ins. Of similar colour to the above horizon but containing a larger amount of timber. Two pieces of fairly well preserved timber taken from this horizon were sent to the Timber Research Officer, Sentul. He stated that these could not be positively identified, but one was probably a branch root of *Carapa* sp.; while the other did not resemble anything in the standard timber collection. According to Burkill (5), *Carapa* sp. belongs to the back of the mangrove belt.

36 to 48 ins. Reddish-brown in colour. The remains of what appeared to be palms were found and as these were not found in any of the other horizons it would appear that they formed a definite era in the peat formation.

48 to 60 ins. The colour remained the same but there appeared to be a concentration of larger pieces of timber in this horizon.

60 to 72 ins. There was less timber but more partially decayed leaves and small strips of bark.

It will thus be seen that the colour of the profile changed from the black of the amorphous oxidised material at the top to the reddish-brown raw material underneath. This shows that the laying down of this peat was a continuous process and that no dry period intervened between the commencement of the peat formation and its cessation, which was due to recent draining of the area.

Laboratory Examination.

Several workers, especially in America and Germany, have carried out investigations into the chemical nature of peat. The presence of a number

of so-called 'humic acids' has received detailed attention, but the examination of these has given information of little value (7).

In peat formation, most of the aerobic organisms are excluded, except on the surface during the dry season. The activities of the anaerobic bacteria are hardly sufficient to break down more than a part of the plant residues which are added annually by the growing plants in the form of roots, rhizomes, leaves and twigs.

The most important chemical problem in regard to the nature of peat is to determine whether this mass of accummulated organic matter results from the incomplete decomposition of all plant constituents or whether some of the plant constituents are readily decomposed and others, which are more resistant to decomposition, accumulate under the anaerobic conditions and thus give rise to the peat.

As an aid to classification, chemical examination would also be of use. Although a large part of the Malayan peat can be classified as woody or forest peat, it is conceivable that different areas are or were concerned with different ecological associations. Thus, although superficially the peat from several areas appears similar, chemical examination might reveal differences in their constitution.

The method of chemical analysis known as proximate analysis, which has been used, has been adapted from that used by Ashworth (8) for Scottish peats. The details of the method are as follows:—

Water Extraction.

10 grms. of air-dried peat is boiled with 300 ccs. of water under a reflux condenser for 1 hr. and then allowed to stand for 24 hrs. to assist coagulation. The solution is then filtered through a poplin cloth on a Buchner funnel, the residue washed and the filtrate made up to 1 litre. Total water soluble nitrogen is estimated in 500 ccs. of the filtrate. A second aliquot is evaporated to low bulk, transferred to a porcelain dish and brought to dryness on a water bath. After further drying at 105°C for half an hour the dish is weighed, the contents ashed at a dull red heat (approx. 500°C) and weighed to give the total water soluble organic (ash free) matter.

Total nitrogen and carbon are estimated by oxidation with H_2SO_4 and by the Walkley-Black method respectively.

Chloroform Extraction.

Five grammes of material, after water extraction, are extracted for 12 hrs. in a Soxhlet apparatus with chloroform. The residue in the flask is dried and weighed and reported as chloroform extract.

Alcohol Extraction.

The material remaining in the thimble, after treatment with the chloroform, is treated with ethyl-alcohol in the same apparatus heated on a sand bath. The residue in the flask is dried and weighed and reported as alcohol extract.

Hydrochloric Acid Extraction.

The material left after treatment with chloroform and alcohol

is refluxed for 5 hrs. with 300 ccs. of 2 per cent. hydrochloric acid, and the extract filtered; the residue is washed on to the filter paper and treated with distilled water until free from acid. The filtrate is made up to 1 litre and an aliquot taken for estimation of nitrogen and reducing sugars. The reducing sugar content is estimated by Benedict's method, using 0.2 per cent. solution of glucose as a standard. The aliquot is neutralised with sodium carbonate and then 10 grms. excess is added. After this, 25 ccs. of Benedict's solution is added and the contents of the flask brought to the boil. The solution of 0.2 per cent. glucose is run in until the end point is reached. The difference between the titration of the standard and the back-titration of the unknown gives the reducing sugar content of the aliquot.

The amount of reducing sugar multiplied by 0.9 gives the hemicellulose content.

Sulphuric Acid Extraction.

The residue left on the paper after treatment with dilute acid is dried for 6 hrs. and weighed. Three grammes of this is taken and added to 25 ccs. of 80 per cent. H_2SO_4 in a conical flask and kept for $2\frac{1}{2}$ hrs. with frequent stirring. The contents are then transferred to a flash having a capacity of 1,500 ccs., diluted to 900 ccs. and refluxed for 5 hrs. The solution is then filtered and thoroughly washed until free from acid. The filtrate is then concentrated and made up to 1 litre and aliquots taken for the determination of nitrogen and reducing sugars exactly as before.

Lignin and Protein Nitrogen.

The residue on the filter paper is dried as before and weighed. One grm. is taken for determination of protein nitrogen and 1 grm. is ashed. By subtracting the value for protein from the figure for ash free residue, a value taken as lignin and allied compounds is derived.

Samples from several areas have been analysed. These include Jalan Kebun, in the Telok Forest Reserve near Klang, Selangor; Pontian, South Johore, and the squatter resettlement area at Pantai Remis in the Dindings, Perak.

The results obtained by the application of this series of analyses are given in Table I.

Table II shows the results obtained for the timber in the various horizons of the profile Pit 1 at Jalan Kebun, Klang. The object in carrying out the wood analyses was to determine the amount of decomposition which had taken place.

Examination of Table I reveals wide variations in the various constituents of peat.

pH Values.

The pH determinations were carried out on a suspension of the fresh, moist sample using the Beckman pH meter. Some of the samples had

Table I.

Results of Analyses Carried Out on Air Dry Samples of Peat.

(Calculated on an Over-Dry Basis)

Sample No.	Depth ins.	Loss on ignition per cent.	pH	Water extract: Nitrogen per cent.	Water extract: Organic Matter per cent.	Water extract: Chloroform extract per cent.	Water extract: Alcohol extract per cent.	Carbon per cent.	C/N ratio	2 per cent. HCL extract: Nitrogen per cent.	2 per cent. HCL extract: Hemicellulose per cent.	80 per cent. H_2SO_4 extract: Nitrogen per cent.	80 per cent. H_2SO_4 extract: Cellulose per cent.	Lignin per cent.	Protein N. per cent.	CaO per cent.
Chenderong Balai, Perak.																
R6842T ..	0— 6	44	5.0	1.38	0.44	1.76	1.53	20.02	15	0.30	7.01	0.079	1.29	20.0	0.44	0.120
Sa ..	6—12	39	5.0	1.20	0.95	2.34	1.24	16.69	14	0.17	6.65	0.051	1.17	22.5	0.38	0.083
Sb ..	12—18	68	5.1	0.85	0.89	4.17	1.41	31.82	37	0.20	5.68	0.065	2.96	42.7	0.56	0.260
Sc ..	18—24	66	5.1	1.00	0.98	4.03	1.98	28.69	29	0.12	5.47	0.057	2.18	40.9	0.56	0.140
R6843T ..	0—12	53	5.1	1.34	0.98	1.65	2.10	26.69	20	0.30	7.24	0.063	1.81	30.4	0.57	0.170
Sa ..	12—30	84	5.2	1.49	1.79	3.63	1.68	33.37	22	0.24	6 60	0.053	1.76	56.9	0.83	0.074
Sb ..	30—42	92	5.2	1.67	2.01	3.10	2.15	38.58	23	0.17	7.89	0.069	1.25	58.9	0.79	0.270
R6844T ..	0— 6	39	5.0	1.01	0.97	1.46	1.32	13.85	14	0.23	7.31	0.072	1.87	19.7	0.48	0.092
Sa ..	6—12	67	4.8	1.07	1.38	4.88	2.24	37.84	35	0.23	6.08	0.070	1.29	42.8	0.61	0.360
Sb ..	12—18	69	4.8	0.96	1.00	6.13	2.08	28.64	30	0.14	6.71	0.070	1.49	42.7	0.56	0.140
Pantai Remis, Perak.																
R6847 ..	0— 6	93	3.4	0.92	2.19	14.27	3.94	35 80	39	0.15	2.39	0.120	2.15	56.7	0 51	0.074
R6848 ..	0— 6	83	3.6	1.52	4.25	6.16	2.38	35.53	23	0.41	5.50	0.130	4.38	49.8	0.66	0.074
R6849 ..	0— 6	93	3.3	1.93	1.87	18.43	3.69	42.47	22	0.14	2 38	0.560	1.97	56.5	0.60	0.126
R6854 ..	0— 6	77	3.8	1.97	1.37	10.20	3.11	33.66	17	0.34	3.14	0.460	1.93	45.1	0.76	0.070
R6855 ..	0— 6	92	3.7	1.83	1.35	5.80	3.14	30.00	16	0.13	1.76	0.430	3.01	63 4	0.92	0.073
R6856 ..	0— 6	85	3.6	1.69	1.29	11.07	3.82	36.00	21	0.33	2.38	0.400	2.36	56.1	0.63	0.045
R6857 ..	0— 6	94	3.7	1.89	2.10	14 03	4.18	40.80	22	0.31	2.17	0.360	1.84	57.8	0.77	0.064
Pontian, Johore.																
R7331T ..	0— 6	56	5.0	0.91	0.80	1.46	1.28	23.86	26	0.29	6.68	0.085	2.65	36.5	0.42	0.111
Sa ..	6—12	68	4.5	0.86	0.92	2.57	1.44	29.52	34	0.31	7.10	0.068	2.74	46.8	0 41	0.123
Sb ..	12—18	82	4.5	0.87	0.57	2.83	1.86	36.55	42	0.26	6.39	0.072	4.78	56.8	0.35	0.067
Sc ..	18—24	74	4.3	0.81	0.79	2.20	1.21	31.60	39	0.28	7 43	0.060	4.53	48.7	0.27	0.106
Jalan Kebun, Selangor.																
R7226T ..	0— 3	95	4.6	0.90	3.50	3.78	4.67	38 90	43	0.098	2.06	0.042	3.13	68.2	0.74	2.092
Sa ..	3—12	98	3.6	0.91	3.44	3.03	5.60	40.79	45	0 023	1.95	0.082	3.90	70 3	0.59	0.773
Sb ..	12—24	98	3.3	0.78	2.87	3.83	4.09	34.88	45	0.033	1.89	0.044	5.97	70.4	0.64	0.352
Sc ..	24—36	99	3.4	0.94	2.27	3.54	3.30	41.53	44	0 025	1.48	0.034	7.32	71.8	0.71	0.169
Sd ..	36—48	99	3.6	0.86	1.71	3.46	3.38	40.98	48	0.029	1.40	0.044	7.35	73.9	0.64	0.109
Se ..	48—60	97	4.0	0.77	2.78	3.57	3.10	43.92	56	0.035	2.00	0.083	7.01	70.5	0 62	0.227
Sf ..	60—72	98	4 2	0.63	1.39	3.22	5.76	41.41	66	0.026	1.54	0.083	7.63	75.8	0.56	0.292

values as low as 3.3, while others, for example the samples from Chenderong Balai, had values greater than 5.0. Thirty-six samples taken from this Station had an average pH value of 5.1, while a series of samples from Pantai Remis in Central Perak, had an average value of 3.6. The samples from Pontian, Johore, and Jalan Kebun, Klang, were intermediate between these two values. Polak (4) states that the peats of Sumatra and Borneo have pH values varying from 3 to 4.5.

It will be seen that there is considerable variation in the acidity of the peat from different areas. The samples from Pantai Remis were from an area of standing jungle while at Chenderong Balai the jungle had been felled and secondary growth had taken its place. The samples from Pontian and Jalan Kebun were from felled and cleared areas. The reason for the higher values of the Chenderong Balai samples is not clear as they appeared similar in most respects to the Jalan Kebun peat and had no close resemblance to that occurring at Sawah Ring, Johore.

Table II.

Analyses of Decayed Wood from Profile Pit I at Jalan Kebun, Selangor.

Depth	Water soluble organic matter	Chloroform extract	Hemicellulose	Cellulose	Lignin	Loss on ignition
ins.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.
0— 3	1.75	0.72	8.47	20.95	60.08	98
3—12	2.31	0.81	6.62	20.58	56.49	98
12—24	2.08	1.88	6.13	19.54	67.35	97
24—36	2.41	1.52	6.51	16.69	64.63	98
36—48	1.95	1.71	6.52	16.52	69.96	98
48—60	1.90	1.25	5.84	14.41	72.60	99
60—72	1.73	1.10	5.68	13.61	71.60	99

C/N Ratio.

Wide variations are shown in this ratio but it will be noted that, in most cases, it is closer in the top than in the lower horizons of the profile. In fact, this ratio gives an indication of the "rawness" of the peat, since, on oxidation, the ratio approaches more closely the average of 10 to 12 usually found in mineral soils.

Water Soluble Organic Matter.

Certain salts, sugars and polysaccharides are soluble in boiling water and these are dissolved in the preliminary treatment of the peat. The amounts extracted vary widely, not only from one area to another but also in samples from the same area. In general, the values are low for the Chenderong Balai samples, while those from Jalan Kebun and Pantai Remis are considerably higher. In Profile I the amount decreases from the top to the bottom of the profile.

Chloroform Extract.

Ashworth, in his work, used a 1:1 mixture of alcohol and benzene for extraction of the Scottish peats. He states that, in the experience of workers at the Macaulay Institute, the material extracted by the alcohol-benzene (1:1) mixture is approximately equal to the combined extracts by alcohol and ether. In this work, however, it was decided that it would be preferable to use solvents singly, and chloroform and alcohol were chosen. Small quantities of *damar*, the resinous material exuded by various species of Malayan trees, have been found in many of the samples of Malayan peat. Past work (9) has shown that *damar* from nearly all species is completely soluble in chloroform but is only partially soluble, and to varying degrees for different species, in alcohol and ether, and thus chloroform seemed a suitable solvent. In addition to dissolving the *damars* and their associated resins, chloroform also extracts the fats, fatty acids and the waxes.

Table I shows wide variation in the amounts of the chloroform extract, some samples having values as low as 2 per cent. while others are as high as 18 per cent. The quantity also varies considerably from one horizon to another in the same profile. In the Chenderong Balai profiles, the amount increases with depth while in the Pontian samples there is an increase in the 6 to 12 ins. horizons. The same also applies to Profile I for Jalan Kebun. Comparison of the values in Tables I and II shows that the chloroform extract is greater in the peat than in the wood, which suggests that this fraction is more resistant to decomposition and is concentrated by the decay of the timber.

The Alcohol Fraction.

Alcohol removes the colouring matter, tannins and phlobaphenes from the peat. The amount varies considerably but is, in general, not so high as the chloroform extract.

The Hemicellulose Fraction.

This group comprises those carbohydrates which are not soluble in water but which are soluble in boiling dilute acids. The hemicelluloses include both pentosans and hexosans (arabans, xylans, galactans, mannans, manno-galactans and various glucans) (7).

This fraction is generally low in Malayan peats.

The Cellulose Fraction.

This group comprises the true celluloses or those carbohydrates which are not soluble in hot, dilute inorganic acids but are soluble in concentrated acids such as 72 to 80 per cent. sulphuric, giving glucose as the only product of hydrolysis (7). In the majority of the samples the cellulose content increases with depth. Samples from Chenderong Balai and Pantai Remis show very low values; on the average 1 to 2.5 per cent., while those from Jalan Kebun give greater values averaging 4 to 6 per cent. Table II shows the much higher content of cellulose in the wood, which disappears as the peat is formed.

Waksman (7) found that the low-moor or eutrophic peats of America contained no cellulose, while the high-moor or oligotrophic peats contained considerable quantities. The results obtained for the Malayan peats show them to be akin to the high-moor peat spoken of by Waksman.

Lignin Fraction.

Lignin is chemically less well defined than the celluloses, hemicelluloses and most other major plant constituents. It is an essential component of wood, of which it forms about 25 per cent. In commercial wood-pulp manufacture, it is extracted by 'cooking' with caustic soda or calcium bisulphite under pressure; in laboratory methods of analyses it is determined as the residue remaining after everything else has been removed by solvents followed by either highly concentrated hydrochloric acid or 72 to 80 per cent. sulphuric acid. From Table I it will be seen that the lignin makes up a large proportion of the organic matter of the peat. The amount increases from the top to the bottom of the profile.

Protein Nitrogen.

In the above method of proximate analysis of peat, the entity remaining after extraction and hydrolysis treatments is certainly heterogenous and contains unknown amounts of substances other than lignin.

The nitrogen content of the lignin fraction is used for a conventional assessment of protein which is assumed to have escaped hydrolysis.

Calcium Content.

The values for CaO content vary considerably, but all can be considered as low. In general, the samples received from the 'raw peat' at Pantai Remis had the lower CaO content. The figures for the analyses support the view that these peats can be classified as oligotrophic.

Shrinkage of Peat.

It is a well known fact that, on drainage, peat shrinks considerably. This process is irreversible for, although it will absorb water after being dried, it does not swell to its original volume. Peat is capable of absorbing and holding tremendous amounts of water and it will hold water so strongly that crops can very easily suffer from drought on it.

In Table III the percentage of moisture found in the samples (as compared with material dried at 105°C in the oven) from the various horizons of profile Pit I is given.

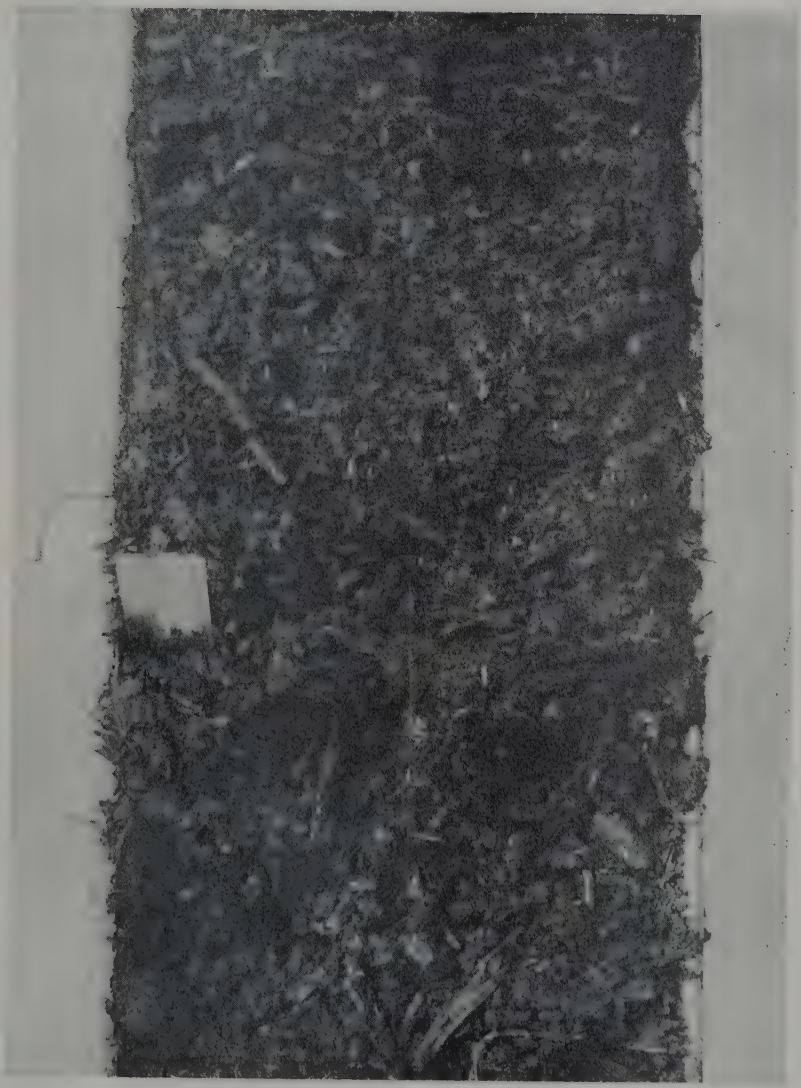
Table III.

Percentage of Moisture in Samples as received from Profile Pit 1.

(Calculated on an Oven Dry Basis)

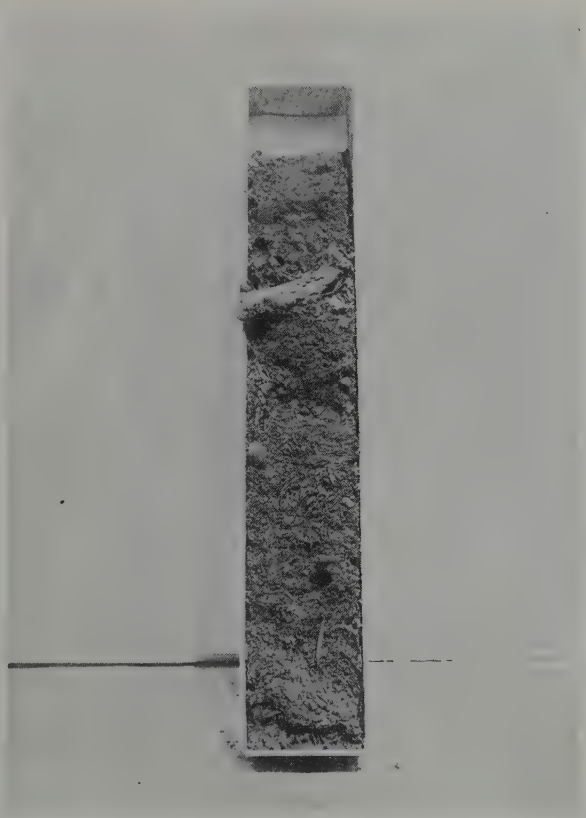
Depth	Moisture
ins.	per cent.
0 to 3	146.1
3 to 12	483.1
12 to 24	730.7
24 to 36	909.9
36 to 48	892.5

PLATE I.



View of Peat in its Undried State.

PLATE II.



Shrinkage of Peat on Drying.

PLATE III.

View of Dried Material.

The water table occurred at 18 ins. from the surface and no rain had fallen during the previous 24 hours. Thus, even when the peat is well drained it is capable of retaining large amounts of water.

In order to study the shrinkage of peat under conditions approaching those in the field, a container 4 ft. x 8 ins. x 5 ins. was constructed of tinned iron, and, by using this, a 4 ft. monolith was obtained. Plate I shows a close-up view of the profile from Pit 1 at Jalan Kebun and illustrates the nature of the peat in its natural state. Plate II shows the same profile after drying for 16 days, while Plate III shows a close-up view of the dried material.

Even though this peat area has been drained and cultivated for a number of years, it is capable of undergoing considerable shrinkage.

Analyses of Inorganic Constituents.

An analysis of the inorganic constituents of a composite sample taken to a depth of 1 ft. at Jalan Kebun was carried out. Table IV gives the values obtained and also, for comparison, the figures obtained by Miller for a sample from the Everglades of Florida (10).

Table IV.

Analysis of Inorganic Constituents of Peat.

	Jalan Kebun Peat		Everglades Peat	
	On Ash	On Dry Basis	On Ash	On Dry Basis
	per cent.	per cent.	per cent.	per cent.
Silica ..	—	—	25.3	1.95
Nitrogen ..	—	1.37	—	3.32
Phosphoric Acid	1.80	0.10	1.69	0.13
Potash ..	6.13	0.34	1.43	0.11
Lime ..	14.95	0.83	39.22	3.02
Magnesia ..	1.80	0.10	5.58	0.43
Al_2O_3 ..	4.32	0.24	8.96	0.69
Fe_2O_3 ..	14.05	0.78		
Mn ..	0.097	0.0054	—	—
Cu ..	0.007	0.00039	—	—
Total Ash ..	—	5.55	—	7.70

The most outstanding differences in these samples are the very much higher lime, magnesia and nitrogen, and the lower iron contents of the Florida peats. Surprisingly enough the potash content of the Malayan peat is higher than the Florida material. The high base content of the Everglades soil reflects the high lime content of the waters flowing into the area.

Pot Experiments with Peat.

Padi.

In 1940 and 1941, some pot experiments on the growth of padi on peat were started by Griffith (11). Peat was obtained from two different areas, one being the Telok Forest Reserve and the other the Briah Swamp in Krian, Perak. Table V gives the results of this experiment:—

Table V.

Results of a Pot Experiment with Padi on Peat.

Area	Yield per pot	Yield per plant	Av. No. of tillers at 2 months	Ht. at 2 months	Ht. at maturity	Loss of Ign. of peat.	Initial pH	Final pH
	grms.	grms.		ins.	ins.	per cent		
Telok, Selangor.	20.2	6.7	1	35	48.4	91	3.1	3.9 to 5.3
Briah, Perak.	48.3	16.1	4	42	54.0	79	3.8	4.3 to 4.8

The report on the crop was as follows:—

Telok Peat. The padi made uneven growth, and the majority of the plants were poor. Better growth was shown in the pots which had a pH of 4.3, 4.7 and 5.3 Two pots with poor growth gave pH values of 3.9 and 4.1. In all pots, ears were of uneven size and there was a high proportion of empty glumes. The surface of the soil became covered with a thick algal film.

Briah Peat. The padi showed good even growth and the ears were uniform and well filled. The rise in pH is rather remarkable. One can only hazard a guess at its cause. It may be that some of the acid was washed out. On the other hand, the irrigation of the pots by the cascade system would lead to the introduction into each pot of water which was well aerated, and this may have led to changes by oxidation.

Recently a further series of pot experiments was carried out on material obtained from the Telok Forest Reserve. The object of these experiments was to test the effect of N.P.K. fertilisers, both singly and in combination, and also copper, manganese and zinc applied as trace elements.

The following treatments were carried out:—

(1) Control. No fertiliser.
(2) Sulphate of ammonia at the rate of 2 cwts. per acre.
(3) Rock Phosphate at the rate of 4 cwts. per acre.
(4) Muriate of potash at the rate of 2 cwts. per acre.
(5) An N.P.K. mixture consisting of the above three fertilisers, i.e., at 8 cwts. per acre.
(6) Muriate of potash at 6 cwts. per acre.

In addition, one pot in each row received a dressing of copper sulphate at the rate of 75 lbs. per acre. Similar treatments with zinc sulphate and manganese sulphate, both at the rate of 25 lbs. per acre, were also given to one pot in each row. Table VI gives the yields from this experiment.

Table VI.

Results of a Further Pot Experiment with Padi on Peat.

Treatment	Mean yield of grain per pot	Mean height at 2 months	Av. No. of tillers per pot which set at maturity	Date of harvest
	grms.	ins.		
Control ..	34.5	19.2	9	23rd July to 23rd August, 1949.
Nitrogen ..	53.4	35.4	15	20th June to 18th July, 1949.
Rock Phosphate ..	40.5	31.8	16	20th June to 4th August, 1949.
Muriate of Potash ..	37.2	33.8	13	20th June to 27th July, 1949.
N.P.K. ..	58.4	38.1	24	17th June to 13th July, 1949.
Triple Potash ..	40.8	31.2	15	18th June to 26th July, 1949.

In no case did the trace elements give any increase nor was the appearance of the plants improved.

This failure of the trace elements to benefit the padi could be attributed to either of the following two causes.

(1) The peat was already supplied with these elements in sufficient quantity and some other element was acting as a limiting factor, or

(2) The dressings were insufficient.

It will be seen from Table VI that nitrogen and N.P.K. gave greatly increased yields over the control. The plants were much healthier and came to maturity earlier than those in the untreated pots. In this experiment, as in the previous one, the pH rose from 4.4. to 5.3

Maize.

It is a well known fact that peat soils after draining too deeply undergo considerable shrinkage through oxidation and irreversible drying. During this process they become hollow underfoot, and, on the surface, a black granular powder is often produced, which is very infertile and in which fragments of weathered resin are common. Oil palms planted on peat have sometimes failed after a short period while, on other occasions, deterioration has set in after a period of normal development. The cause of this has yet to be elucidated but the symptoms are such as could result from starvation. On one estate in Selangor where such an occurrence took place the young palms were abandoned but even years later there remained large bare patches with powdery, black surface soil on which grasses or weeds, however hardy, refused to grow. This powdery surface contained a high proportion of chloroform soluble matter. The peat below the surface layer was of normal appearance and was utilised for pot experiments with maize. The peat was so infertile that if the maize germinated at all it failed to give any further growth. Some of the peat was steam sterilised but this had no

beneficial effects, nor had the addition of fertilisers. Addition of calcium carbonate in progressively larger amounts produced an effect but the equivalent of 14 tons of calcium carbonate per acre was needed to raise the pH from 3.4 to 6.4, at which point the maize would grow to 12 ins. before dying back.

A similar finding is reported by Ehrencron (12) who found that the root system of the maize in the unlimed pots was limited to the top layer of only a few centimetres.

Field Experiments with Peat.

Ramie has proved a very successful crop on the peat of the Florida Everglades and it was considered that it would be of interest to examine its growth on the Malayan peats. Since the Florida experiments (13) have proved that the addition of trace elements, especially copper, gave greatly enhanced growth, it was considered that the addition of trace elements to the Malayan peat would be worth a trial.

A randomised block experiment was laid down at Jalan Kebun, Selangor, to test the effect of 8 different treatments. These included dressings of sulphate of ammonia, rock phosphate and muriate of potash, singly and in combination as N.P.K., and also three trace element treatments consisting of copper sulphate, zinc sulphate and manganese sulphate. The rhizomes were planted under favourable conditions on an area of peat which had been cleared of lalang and secondary jungle growth but none of the plots gave good growth and all the treatments appeared to be without effect. The plants came up a few inches above the ground but then became stunted and yellow. In one or two very small areas where rubbish and lalang roots had been burnt the plants grew well.

At the same time, a half acre block was planted in rows on burnt ground. The burning was effected by gathering together rubbish such as roots and pieces of wood, and a small layer of the surface of the peat and burning this in drills about 4 ft. apart. The rhizomes were then planted in these drills. Very good and even growth was obtained and the plants appeared green and healthy. Further experiments of this nature are being carried out.

Discussion.

In the study of peat soils in Malaya, several important features emerge. One of the most important considerations is the classification of these soils. From a practical point of view we can divide the peats of the West Coast into three broad areas.

(1) Pontian area of South Johore. It is on this area that the large scale development of pineapple growing will take place.

(2) Selangor. On some of the peats in Selangor, Chinese market gardeners are settled and they produce the usual market garden vegetables such as colocasia, sweet potato, etc. Again, some oil palm estates are situated either partly or completely on peat even though none of this is of great depth. The Tanjong Karang padi scheme, extending to some 65,000 acres, involves large areas of peat, though little development has as yet taken place on the deeper peats in this area.

(3) Trans-Perak. In this area the development of a large scale padi scheme is envisaged.

Although the work so far carried out has of necessity been very cursory it would appear that, stratigraphically, the peats from these areas are all similar in that they have been developed from forest under swamp conditions. As far as their chemical make up is concerned, although there is considerable variation between samples from the same area, there does not seem to be any consistent variation between the different areas.

It would appear that the best method of approach to this peat problem would be the examination of the stratigraphy of profiles from various areas and attempts to identify the timber occurring therein. This, together with the carrying out of further chemical analyses on the same lines as those already undertaken, should enable a classification of the peats to be made. It must be emphasised that this classification is of the utmost importance in order that the experimental results obtained from any one area can be extended to other parts of the country.

Another problem which has appeared is that concerned with the burning of the peat. As has been shown in the ramie experiments, burning of the surface layer is distinctly beneficial. Again, most of the Chinese farmers working on peat make a practice of burning it before planting their crops. The problem is what is the effect of this burning. It certainly increases the relative amount of potash and lime in the surface layer, but potash, when applied, did not appear to have any beneficial effect on the peats. The alternative explanation appears to be that it destroys some toxic factor in the soil. If burning is indeed beneficial then the question arises as to how often burning should take place in order to make the most economical use of the peat. In contrast to mineral soils, where plant nutrients are liberated by the weathering of the minerals, the plant nutrients in the peat are locked up in the organic material and can only be liberated by oxidation. Thus, destruction of the peat is bound to take place, slow though it may be, and it would seem that controlled burning would not be much more destructive in the long run.

These woody and fibrous peats of Malaya will require considerable decomposition before they are converted into a stable soil mass. The importance of the decomposition processes cannot be over-emphasised in the handling of these soils. In the first place, the comparative slowness with which the reactions take place would dictate the need for careful control of the water table so that optimum conditions for aeration and natural oxidation may be maintained. On the other hand, good judgment in the development of the proper conditions must be used, as the occurrence of these reactions in excess will lead to unnecessary dissipation of actual soil material due to over-exposure.

Two entirely different systems of cultivation are employed on the peats of Malaya. Firstly, there is the cultivation of padi where reducing conditions, due to inundation, prevail in the soil for 4 to 5 months annually and on which, if mechanical cultivation is to be developed, studies of the best methods of drainage will be of paramount importance. Secondly, the

growing of dry land crops, e.g. pineapples, leaves the land exposed to oxidation processes throughout the year; the problem in this case will be to arrange the drainage so that over-oxidation does not take place and the plants do not suffer from drought. Thus, experiments on peat will have to be designed to take these two different problems into account.

Summary.

The occurrence and formation of peat in Malaya has been discussed and it has been noted that most of the material so far encountered has been of the woody or forest type formed under swamp conditions.

The name "bog soils" has been suggested to cover all swamp deposits in Malaya, and it has been shown how these peats compare with the various types found in other countries.

A detailed contour map of the peat depths occurring at the mechanisation test plot at the Federal Experiment Station, Chenderong Balai, and a detailed description of a soil profile at Jalan Kebun, Klang, are included. A short description of the general morphological characteristics has been given.

An outline of a method of chemical examination has been included. This examination has shown that Malayan peats, in spite of the fact that they are formed in low-lying areas, are more closely akin to the high-moor or oligotrophic peats of the temperate countries than the low-moor or fen peats.

A summary of the results of several pot experiments with padi and maize growing on peat has been given. These experiments have shown that Malayan peat, as represented by material from the Telok Forest Reserve, Selangor, will not support a good growth of padi but that a dressing of N.P.K. greatly improves the yield and appearance of the plants.

Burning of peat has been shown to be beneficial for ramie cultivation.

The problems which will have to be considered in the future development of cultivation of both wet and dry peat have been discussed and factors requiring further investigation suggested.

Acknowledgements.

The writer wishes to thank Dr. T. A. Buckley, Acting Chief Research Officer, for much helpful criticism and advice in the carrying out of the investigations and in the preparation of this article, and also Mr. Gunn Lay Teik, Acting Senior Chemist, for carrying out certain of the analyses.

References.

(1) Mohr E. C. "The Soils of Equatorial Regions with Special Reference to the Netherlands East Indies" 1944.

(2) Dacknowski-Stokes A.P. "Report to the Subcommission for Peat Soils of the International Society of Soil Science". Proc. 2nd Int. Congr. of Soil Sci. 1930 Vol. VI.

(3) Dacknowski-Stokes A.P. *J. Amer. Soc. Agron.* 22, 1930, pp. 352-366.

(4) Polak B. "Veenonderzoek in Nederlands Indies". *Meded. Alg. Proef. Landbouw* No. 53, 1941.
(5) Burkill I. H. "A Dictionary of the Economic Products of the Malay Peninsula." 1935.
(6) Map of Borings Carried Out by the Dept. of Mines, Fed. of Malaya.
(7) Waksman S.A. and Stevens K.R. *Soil. Sci.* 26, 1928, pp. 113-137.
(8) Ashworth M.R.F. *J. Agric. Sci.* 32, 1942, Pt. 4, pp. 349-359.
(9) Buckley T.A. Malayan Forest Records No. 11, 1932.
(10) Miller C.F. *J. Agric. Res.* 13, 1918, pp. 605-609.
(11) Griffith G. 1940. Unpublished Report.
(12) Ehrencron K.R. Orienterende Potproeven Met Zuur Bosveen Van Borneo. *Meded. Alg. Proef. Landbouw* No. 90, 1949.
(13) University of Florida *Agric. Expt. Stat. Bull.* 412.

NATURAL CROSS POLLINATION OF WET PADI IN MALAYA

BY

L. N. H. LARTER,

Botanist.

The technique of improving padi (rice) varieties by pure line selection and maintaining purity in seed multiplication is to a large extent based on the assumption that the great majority of padi flowers are self-pollinated under conditions normally occurring in the field. It is well known, however, that some cross-pollination does occur naturally, and while this is usually negligible in any one season, its cumulative effect over a number of years may be sufficient to modify the characteristics of a variety radically. Protection of the inflorescence from airborne pollen by bagging is satisfactory in eliminating cross-pollination but decreases setting of seed and cannot therefore be practised where yield data are required. Bagging is also objectionable in cases where colour characters are of importance as it often modifies the expression of pigmentation in floral organs. Furthermore, where selection is being carried out on an initial population of over 50,000 plants, costs of material and labour become disproportionately high.

Investigations in other countries have indicated that the degree of natural out-crossing which may occur in different varieties under different climatic conditions varies from 0 to 23 per cent.(1). It is therefore of importance to determine what degree of natural cross-pollination may be expected in Malaya in conditions under which selection work is being carried out. The experiment described below was therefore undertaken as a preliminary assault on this objective.

Unpublished experiments conducted in Malaya at the Titi Serong Padi Experiment Station, Perak, during the period 1931 to 1933, indicated that there might be considerable variation in the amount of cross-pollination according to variety, health of plant, and weather conditions, and that, although the normal percentage of natural cross-pollination might be less than one, if plants were affected by stem-borers, or if the sky was very overcast and cloudy, dehiscence of the anthers would be delayed so that the extent of cross-pollination could, apparently, amount to as high as 14 per cent.

Records of these earlier experiments have not survived, and furthermore, there is some doubt, now, as to the complete reliability of the material used and the results obtained, so that there was need for further experimentation.

Material.

Ideally the planting material used should have been inbred by protection from cross-pollination for a number of generations to ensure homozygosity, but such material was not available. Pending the provision of more suitable material this preliminary experiment was carried out using, as female parents, the four well known varieties (A) Nachin 11, (B) Siam 29, (C)

Reyong 6 and (D) Milek Putch 9, all of which were originally pure line selections and have been maintained in a high state of purity by rogueing. These four varieties bear no pigmented vegetative or floral organs, produce white vitreous rice and are unawned. They are distinguishable from one another by straw and grain characters. The seed used was selected from multiplication plots which had been thoroughly rogued and had been raised from stocks in which pigmentation and the other characters under study had not appeared in several preceding generations. It was therefore assumed that these varieties were homozygous for the absence of pigmentation, though the possibility of colour genes being present in the recessive condition could not entirely be eliminated.

The male parents should preferably have been selected from pure lines with simple mendelian characters of clear expression present in the homozygous dominant condition. Characters which suggested themselves as suitable from the viewpoint of expression and scoring included pigmented pulvinus, internode, glume, lemma, apiculus and kernel, awned lemma and *pulut* (glutinous) kernel. In the absence of any previous genetic analysis of Malayan padi, nothing was known of the dominance of, or number of genes determining these characters nor were pure lines of suitable varieties available. The characters selected were, therefore, those which had proved to be simple mendelian dominants in the majority of cases investigated by workers in other countries. In general it has been found elsewhere that pigmentation is dominant to lack of dark pigment, awned lemma dominant to awnless and vitreous dominant to glutinous endosperm. The five varieties used as male parents were selected on the basis of uniformity in the field and of the threshed grain. Their characteristics are set out in Table 1.

It was expected that the male parents would not only be heterozygous in some degree but also be contaminated by off-types. All the seed used was therefore hand-picked to remove obvious contaminants. Examination of samples of the glutinous variety used, Pulut Agam, showed that it contained 12.2 per cent. of hard (vitreous) grain by inspection but on treatment with iodine only 4.3 per cent. proved to be starchy.

Method.

As the primary interest in this experiment was in its relation to the effect of out-crossing in ear-row selection work, the experiment was laid out in a similar manner to the selection plots. Varieties were planted in single rows spaced 18 ins. apart with single plants 12 ins. apart within the rows. Each row contained 50 to 70 plants. Rows of pigmented and unpigmented varieties were planted alternately in this order:

Row.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Variety.	A,	E,	B,	F,	A,	G,	B,	H,	A,	J,	C,	F,	D,	E,	C,	G,	D,	H,	C,	J.	D.

The maturation period of all varieties used was known to be approximately similar, though the exact life of varieties E to J was not known. The first (P_1) generation was therefore sown on 16th June, 1948, in a wet nursery and transplanted to the *sawah* on 28th July. Owing to slight attack by *ulat layar* (*Nymphula* sp.) and the patchy nature of the soil of the area used, uniformity of growth was disturbed, with the result that the flowering period

Table I.

Characters of Parents.

Character.	Variety					
	Female Parents (A to D)	Kedudok (E)	Janda Mengikut (F)	Merah Isi (G)	Pulut Agam (H)	Kelopak (J)
Pulvinus ..	n = green	n.	n.	purple	n.	purple
Internode ..	n = green	n.	purple	n.	n.	purple
Glume ..	n = white	n.	red	red	red	red
Lemma, unripe ..	n = green	purple	purple	purple	red	n.
Lemma, ripe ..	n = straw	grey	purple	brown	brown	n.
Apiculus ..	n = green	n.	purple	purple	purple	red
Awn ..	absent	absent	absent	absent	absent	present
Pericarp ..	white	black	white	red	white	red
Endosperm ..	n = vitreous	n.	n.	n.	glutinous	n.

was extended, and while flowering of the whole experiment was not simultaneous there was considerable overlap between all adjacent rows. Apart from this, no extraneous factors likely to modify the normal chances of cross pollination intervened.

Sowing of the F_1 generation was commenced on 29th June, 1949, and transplanting on 9th August on more uniform land. No damage from pests etc. occurred and plant survival, growth and uniformity were satisfactory. Four rows of 60 to 70 plants of the unpigmented varieties (A to D) were planted from random samples of the bulked seed from each row of these varieties grown in the previous generation. At the same time, single rows of the pigmented varieties (E to J) were planted to study heterogeneity and obtain homozygous material for future use. At flowering two plants in each row of all varieties were bagged for the latter purpose. All plants were examined in the field prior to maturity for scoring characters. Each plant was reaped separately and again examined after harvest.

Results.

First Generation.

In the P_1 generation a few rogue plants appeared in the rows of varieties A to D; these were removed prior to flowering. Otherwise all plants in the rows of these varieties appeared true to type.

Genetic heterogeneity of the pigmented varieties was indicated by variation in the intensity of pigmentation in most varieties and by presence of some white pericarps and awnless grain in the yield of Kelopak and a considerable amount (13.1 per cent. by inspection) of vitreous rice in the *pulut* variety. This amount, however, was not significantly higher than that occurring in the original stock (12.2 per cent.). In the absence of a significant difference no conclusions can be drawn as to the genetic constitution of the original stock of Pulut Agam or as to the degree of cross-pollination in this generation, except that the latter could not be more than a few per cent. at the most. There was no significant difference in the frequency of vitreous grain from the two rows of Pulut Agam grown.

Second Generation.

Results from the F_1 generation of the unpigmented varieties (A to D) were as follows:—

Nachin 11. Rows 1 to 4.—294 plants raised from seed from Row 1 grown adjacent to Kedudok in the previous generation. No plants with pigmented organs, or coloured rice appeared. One plant identical with Siam 29, and 9 with Reyong 6 appeared.

Rows 11 to 14.—291 plants from Row 5 previously grown between rows of Janda Mengikut and Merah Isi. Four plants, probable hybrids, with purple pulvinus, internode and apiculus, red tinged glumes and lemma, and white kernel. One plant identical with Reyong.

Rows 24 to 27.—286 plants from Row 9 grown between Pulut Agam and Kelopak. One probable hybrid with purple internode, glume, lemma and apiculus but grain of Nachin shape. Three pigmented

plants, possible hybrids, unreaped. One plant identical with Kelopak, 2 plants identical with Reyong.

Siam 29. Rows 6 to 9.—289 plants from Row 3 grown between Kedudok and Janda Mengikut. No pigmented plants appeared. Two plants identical with Reyong.

Rows 16 to 19.—283 plants from Row 7 grown between Merah Isi and Pulut Agam. Two probable hybrids, one with pigmented internode, glume, lemma and apiculus, the other unpigmented but with short grain. Four plants identical with Reyong.

Reyong 6. Rows 29 to 32.—256 plants from Row 11 grown between Kelopak and Janda Mengikut. No hybrids. Two plants identical with Siam.

Rows 39 to 42.—274 plants from Row 15 grown between Kedudok and Merah Isi. One probable hybrid resembling Reyong in habit and ear (Kedudok possesses a very open ear) but with black pericarp and pigmented lemma and apiculus. One plant with grain resembling Radin Siak, a variety not included in the experiment, in shape and pigmentation, possibly a hybrid but more probably a rogue.

Rows 52 to 55.—268 plants from Row 19 grown between Pulut Agam and Kelopak. Three probable hybrids, two with pigmented glume, lemma, apiculus and red pericarp but resembling Reyong in shape, and one, unreaped, with pigmented apiculus. One plant identical with Siam 29.

Milek Puteh 9. Rows 34 to 37.—282 plants from Row 13 grown between Janda Mengikut and Kedudok. No apparent hybrids. One plant identical with Reyong.

Rows 44 to 47.—285 plants from Row 17 grown between Merah Isi and Pulut Agam. No apparent hybrids. Two plants identical with Reyong and 2 with Siam.

Rows 57 to 60.—282 plants from Row 21 grown beside Kelopak. Four probable hybrids with purple internode and lemma, red glume and pericarp, one of which was awned. One plant identical with Siam and 6 with Reyong.

These observations are summarised in Table II.

Of the 4 plants recorded as 'possible hybrids', 3 were noted in the field but were not discovered among the harvested plants; this may have been due to loss during harvest or more probably to bleaching of the pigmentation at maturity. The 4th was not noted in the field but was first found among the harvested plants, it is most probably a rogue but, in the absence of a knowledge of the inheritance of pigmentation, must be classed as a possible hybrid at present.

It will be noted that, in certain rows, 40 plants occurred which appeared indentical with varieties planted in other rows, e.g. the occurrence of Siam and Reyong plants in the Nachin rows. It is highly improbable that these are of hybrid origin as this would imply that all the distinguishing characters of these varieties (Reyong and Siam) are completely linked and dominant to the corresponding characters of Nachin and Milek Puteh. While this is not impossible, as the number of characters involved may be few,

Table II.

Occurrence of Off-type Plants in F_1 Generation.

Variety	Total No. of Plants	Probable Hybrids	Possible Hybrids	Total	Per cent.	Probable Rogues	Total Off-Types	Per cent.
A. Nachin 11 ..	871	5	3	8	0.92	19	27	3.10
B. Siam 29 ..	572	2	—	2	0.35	6	8	1.40
C. Reyong 6 ..	798	4	1	5	0.50	3	8	1.00
D. Milek Puteh 9	849	4	—	4	0.47	12	16	1.88
Total	3090	15	4	19	0.48	40	59	1.91

it will be noted that Siam plants occurred in the Reyong rows and *vice versa*. Furthermore, in the previous generation, no plants of Reyong occurred within 10 rows of Nachin Row 1, and no plants of Siam 29 within 14 rows of Milek Puteh Row 21. It is most probable that these plants are indeed attributable to the varieties which they resemble and that their presence out of place is due to errors of technique. In spite of inspection of the seed planted, a few off-type grains may have been overlooked, but more probably mixing may have occurred during sowing or by disturbance of the seed beds by rodents or birds. In the circumstances it seems reasonable to assume that these plants classified in Table II as 'probable rogues' may be attributed to experimental error.

As a further check of hybridity it is proposed to grow an F_2 generation of the apparent hybrids as well as the 'probable rogues.'

Conclusions.

On the assumption that all off-type plants found may be attributed to natural cross-pollination, the degree of hybridity due to this cause is 59/3090, or of the order of 2 per cent. It has been argued above, however, that this assumption is not correct and that the total occurrence of true hybrids is 19/3090 or 0.48 per cent. This latter figure is probably an underestimate of the normal expectation of cross-pollination, that is, fertilisation by extraneous pollen, for two reasons. Firstly, the non-simultaneity of flowering in the P_1 generation reduced the chances of cross pollination between adjacent plants which, unless the density of air-borne pollen was continuously high, would depress the occurrence of hybrids. Secondly, the probability of heterozygosity in the male parent varieties would allow of cross-pollination occurring without producing visible effect. It is doubtful whether proper compensation for the combined effect of these two factors would be sufficient to increase the results seriously and it is probable that the real amount of cross-pollination which occurred was less than 1 per cent. These figures are of the same order as those found by similar experiments in Ceylon (1, 2, 3) where it is thought that the figure may vary widely according to variety and climatic conditions. Similar variation may be expected under Malayan conditions and it is proposed, therefore, to repeat this experiment with an improved technique on other varieties in other localities. For this purpose, homozygous lines of suitable male parents are being bred, and the purity of the female parents checked. Meanwhile for the purposes of selection work it is being assumed that the expectation of occurrence of hybrids as a result of natural cross-pollination is of the order of 1 per cent.

References.

1. Lord, L. "A preliminary Study of Natural Cross-pollination of Rice in Ceylon." *Ann. Roy. Bot. Gdns. Peradeniya*, Vol. XI. Pt. 4. pp. 339-342, February, 1932.
2. Kadam, B.S. & Patil, G.G. "Natural Cross-fertilization in Rice." *Poona Agric. Coll. Mag.*, Vol. XXV. No. 2. pp. 53-61, September, 1933.
3. Haigh, J.C. "A Note on the Natural Cross-pollination of Rice in Ceylon." *Ceylon Journ, of Sci.* (A). Vol. XII. Pt. 2. pp. 121-122, October, 1936.

MUD AND WATTLE SMOKE-HOUSES FOR RUBBER AS USED IN CEYLON

By

L. R. Davidson,

Smallholders' Advisory Officer,

Rubber Research Institute of Malaya.

These notes have been prepared following a short visit to Ceylon, where, under the guidance of officers of the Rubber Research Scheme (Ceylon), I was able to observe the common use of mud as a building material, and particularly the construction of smoke-houses with mud and wattle. In Ceylon the smoking of rubber by individual smallholders appears to be much more general than it is in Malaya. One factor which encourages this is the rubber buying depots in various parts of the country under the Commissioner of Rubber's Office. These depots buy only smoked rubber but guarantee the producer a fair price for his produce, according to grade, provided that it is smoked. There is no doubt, however, that familiarity with a cheap and durable building material is of considerable importance in enabling the owners of quite small areas to have their own smoke-houses.

The importance of the smoking of sheet rubber to the return which the smallholder can receive hardly needs emphasis. Faults due to sand, dirt, or bubbles cannot be detected in airdried sheet but only become apparent in the translucent smoked sheet. No matter how carefully sheet is prepared it is unlikely to be bought at the price of No. 1 rubber unless it is smoked. Normally, payment received by smallholders does not exceed No. 3 grade and this for unsmoked rubber is often about 25 per cent. below the price of No. 1 R.S.S. There are therefore good grounds for smallholders marketing their rubber in the smoked form.

There seems to be no reason why mud smoke-houses should not be successfully employed in Malaya. Mud as a structural material has advantages over the inexpensive building materials which have been used in this country, and it is reasonable to suppose that knowledge of its use might result in an extension of the smoking of rubber by smallholders. Mud and wattle provides a durable structure and, in Ceylon, buildings of this material last for 20 years and more. It is retentive of heat and should effect some economy of fuel while the fire risk is also reduced; so also is the danger of theft when compared with flimsier structures of bamboo and gunny sacking.

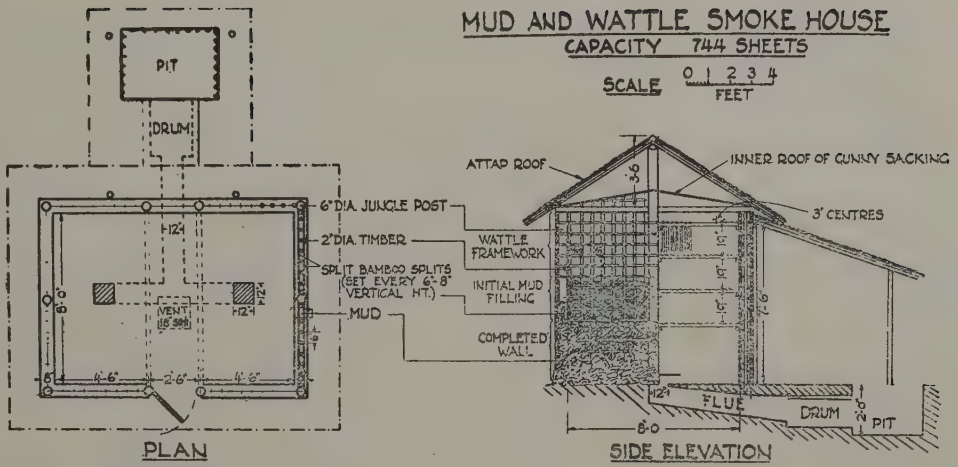
A preliminary note on the construction of mud and wattle smoke-houses may therefore be of interest. In Ceylon, smallholders generally smoke their own rubber and a "cabinet" type of smoke-house is popular. It was therefore smoke-houses with internal dimensions of 5 x 5½ft. and height 7½ft. that provided most of the examples seen by the writer and they form the basis of this note. There was, however, plenty of evidence that mud and wattle can be used satisfactorily on larger structures, and plans for smoke-houses can easily be adapted to requirements.

PLATE I.

MUD AND WATTLE SMOKE HOUSE

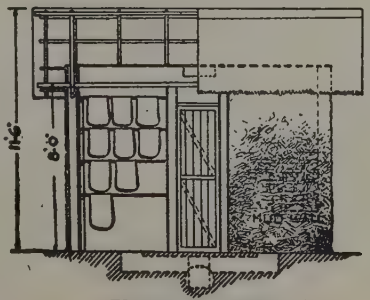
CAPACITY 744 SHEETS

SCALE 0 1 2 3 4 FEET

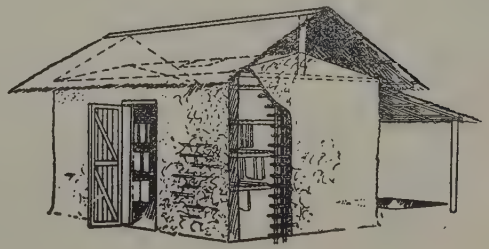


PLAN

SIDE ELEVATION



FRONT ELEVATION



The use of mud building is so general in Ceylon that the range of soils which will serve the purpose must be very wide indeed. A gritty texture and a high clay content are both essential and a standard of 2 parts sand to 1 part clay as shown by a sample settling test in water which has been suggested in a Ceylon work on pisé-de-terre is probably equally suitable for mud and wattle structure. In practice only extremely sandy soils which will not bind and fine clays which crack on drying are entirely unsuitable.

The first step in mud and wattle building is to erect the main framework and put on the roof. Corner posts and posts to carry the door are generally round, hard-wood timbers about 6 ins. in diameter. It is advisable that the lower end of such timber should be dipped in hot tar to protect them below and immediately above ground level. For larger buildings it is an advantage to plant the uprights in broken stone or concrete foundations. It would seem to be advisable, though not necessary, at this stage to fit all the bearers necessary to carry the timbers in the finished smoke-house. The outer roofing in Ceylon is generally of coconut kajangs and the ridge is 3ft. 6ins. above the top of the walls. Such a roof covering lasts for about two to three years in Ceylon.

For the vertical part of the wattle structure poles of about 1½ to 2ins. diameter are required. Almost any easily available wood is used for this purpose. The poles are fixed along the lines of the sides about 6 to 8 ins. apart. The lower ends after being plunged in hot tar or asphalt are buried about 6 ins. in the ground and at the top they are tied to the cross beam. Horizontal strips are then fixed in pairs at 6 to 8 ins. vertical intervals one on each side of the vertical poles and lashed at each junction with coir twine. These horizontal pieces are usually strips of split arecanut palm about ¾ to 1 in. thick. Bamboo would probably serve equally well for this purpose.

The next step is to prepare the mud. The site for excavation should, of course, have been chosen in suitable relationship to the smoke-house site. Top soil containing roots and organic matter is discarded and soil from a few inches down is then cut and thoroughly loosened. Water is added and the mixture thoroughly worked by treading and adding water as required until the right consistency is reached. This can be determined only by experience but the mud should be mixed and wetted until it can be worked into large round lumps, about 8ins. across, which can be moulded without crumbling. Starting from the bottom of the wall these lumps are placed in the gaps in the framework and further interstices filled by working in more mud. A throwing action is useful at this stage and, to make a good job, kneading with fingers is also necessary. Mud is filled in until the wall is more or less flush with the horizontal parts of the framework. It is best not to attempt to raise the height of the wall more than 2 or 3 ft. at a time and an interval of a day or more should be allowed for drying and consolidation before another layer is added.

When all the walls are completed the building should be left for about 10 days in good drying weather before a final plaster of mud is applied. This should be done with a wetter mix than the original building. A layer about ½ in. thick will be required to cover all the framework and irregularities in

the structure. The facing is finally smoothed down with a straight-edged section of planking. Mixing a little cow-dung in the final rendering might give a better finish but does not seem to be used often. The final plaster in fact is often omitted but the walls are then more susceptible to crumbling and decay. The completed wall is about 8 ins. thick.

The inner roof is fitted about 8 ins. below the kajang roof and is generally of hessian with flaps cut for ventilation. The tarry materials in the smoke rapidly fill the weave of the hessian and make it more or less impermeable. Inlet ventilation is easily adjusted by leaving suitable holes in the walls about 6 ins. from ground level.

There seem to be many points which should favour the building of such smoke-houses by the owners of small rubber holdings in Malaya. Materials are cheap and labour would be the principal item in construction. The art of such building would certainly be within the capabilities of most smallholders after a little experience had been gained. Jungle or secondary jungle is generally much more accessible to smallholders in Malaya than to the people in Ceylon, and better quality timber would be more readily obtainable. Arecanut trunk, which is so commonly used in Ceylon, is not a very durable material and it should be possible to improve on this in Malaya. So too rotan ties, generally readily obtainable in this country, should be more durable than coir string, and atap roofs are more lasting than coconut kajangs.

Only experience of the technique of construction is lacking and we are now taking steps to obtain such experience in trials in various parts of the country. Plans for a mud and wattle smoke-house with a capacity for about 1,000 lbs. of rubber, which may be suitable for use in Malaya, are shown in Plate 1 but the plan can, of course, be modified according to requirements. We hope we shall shortly be able to publish information obtained from the construction and operation of such smoke-houses in Malaya.

My thanks are due to the Director of the Rubber Research Scheme (Ceylon) for the assistance given by members of his staff. Arrangements for my tour were made by Mr. W. I. Pieris, Small-Holdings Propaganda Officer, and his helpful advice enabled me to make the best use of the time available for the visit. I also have to thank Mr. W. K. de Silva and Mr. H. H. Peiris for their tireless guidance during three days when they showed me much of interest in Ceylon and particularly the smoke-houses and building practices on which this article is based.

FLACOURTIA INERMIS. — ROKAM MASAM

BY

C. W. S. HARTLEY,

Senior Agricultural Officer, (Research).

Flacourtia inermis is a minor fruit tree of Indonesia and Ceylon. It is not recorded in either Ridley's "Flora of the Malay Peninsula" or Corner's "Wayside Trees of Malaya," though Burkill (1) mentions it as being found throughout Indonesia in cultivation, and sometimes planted in the Malay Peninsula. He records that it was observed in Penang as long ago as 1819. Ridley (2) mentions it briefly in an article describing both native and introduced fruits. In 1939 I found it to be growing in appreciable numbers in the Balik Pulau district of Penang where it is known as *buah Rokam*, or more exactly, *Rokam masam*. Further investigation showed that it was almost entirely confined to this district. Two trees in Province Wellesley, one growing at Pekan Darat and the other at Tassek Junjong, and a small number of trees in the North-East district of Penang were all acknowledged to have owed their origin to seed brought from the Balik Pulau district. It is a curious fact that this tree, although quite common in this district, has apparently escaped notice for so long. Another curious point is that although all the inhabitants of the area say that *Rokam masam* trees were to be found in the district for as long as they or their fathers could remember, no very old trees have been noticed. It is said that the tree deteriorates rapidly after it reaches the age of 20 years but, on the other hand, diseased trees have not been noticed.

One of the nearest relatives of *Rokam masam* is the common *Rukam* or *Rokam manis* (3) (*Flacourtia rukam*). This tree is found throughout Malaya and can be distinguished from *Rokam masam* by the fact that it is thorny, that the fruits are greenish red and not bright red as in *Rokam masam*, and that it has styles arranged in a circle instead of being bunched together.

Scolopia rhinanthera, a thorny bush commonly found adjoining the padi fields in Province Wellesley and Kedah, is also called Rokam by the Malays. This plant also belongs to the Flacourtiaceae but is however of no economic importance. The Krekup, *Flacourtia jangomas*, is also sometimes wrongly referred to by Malays as Rokam.

Seed of *Flacourtia inermis* was brought to the Federal Experiment Station, Serdang, from Java by Mr. J. N. Milsum in 1939, and three well-grown trees are now to be found in the Fruit Nursery there.

Description.

Flacourtia species are small trees many of which have thorny trunks and branches. *Rokam masam* is exceptional in being thornless. In Ceylon it reaches a height of 25 to 30 ft. The foliage is dense and the trees have

an attractive appearance, particularly when young leaves (which are pink) are developing or when a full crop of fruit is ripe. The leaves are shiny on both sides, have serrated edges and may reach a size of 6 ins. long by 3 ins. broad. Unlike other species which are normally unisexual and dioecious, *Rokam masam* is bisexual. The flowers are in short racemes and are without petals. The fruits are bright red berries, in colour and size resembling a good sized cherry. The bright red colour and the arrangement of the styles in a bunch distinguish these fruits from those of other species.

Propagation, Growth and Yield.

In Ceylon (4) *Rokam masam* is propagated by seeds which are sown in seed boxes and transferred to baskets where they remain for about 18 months before being planted out in the field. In Java (5) it is said that as the tree does not come true from seed it is usually propagated by marcots or by budding by the modified Forkert method on *Flacourtia inermis* or *Flacourtia rukam* stocks. The trees growing in Penang are undoubtedly seedlings and there does not appear to be much variation in the fruit.

There are no exact records of the age at which this tree comes into bearing, though it is probable that it is at about 4 to 6 years of age. In Ceylon there are two main seasons while in Java it is reported as flowering only in January and February with ripe fruit on the trees from May to July. Fruiting records have lately been kept on three trees in the *kampong* in Penang and on three trees, spaced 37 and 25 ft. apart, at the Federal Experiment Station, Serdang. The trees at Serdang were imported from Java in 1939 and are said to have fruited for the first time in 1943. A record at Serdang shows that the period from flowering to fruiting is about 3 months. Flowering is irregular, with two or three main crops during the year. It is not at all uncommon to find fruit at two stages of growth and flowers on the tree at the same time.

Table I shows the yield of fruit harvested from the trees over a one year period. In Penang, records were kept from December, 1946 to November, 1947 inclusive. At Serdang the records are for the period December, 1947 to November, 1948. Table II shows the girth and height of these trees. It will be noted that the trees in Penang are taller in proportion to their girth than those at Serdang; this is no doubt due to the fact that the former have been 'drawn up' by the surrounding *kampong* trees. The good health of the Serdang trees, however, shows that this species does not require shade and thrives very well in full sunlight. Some older trees in Penang are reported to have reached a height of 40 ft.

Uses.

In Penang the Malays use this fruit for making two kinds of pickle. Jam or jelly can also be made from the ripe fruit. Good jelly, resembling red currant jelly, has been made in Malaya from fruits of both the Penang and the Serdang trees. In Ceylon it is stated that the fruits "make good jelly or preserve, but require much sugar". In Java the fruit is described as being "eminently fit for jam, syrup and preserves for which it is generally used. The fruits are too sour and too astringent to be eaten raw. But

Table I.

Yield of Rokam Masam Fruits.

(Recorded over a period of 1 year).

Penang Kampong trees.					Federal Experiment Station, Serdang. Java trees planted in a triangle 37 ft. x 25 ft. x 25 ft.				
Month	Tree 1	Tree 2	Tree 3	Average	Month	Tree 1	Tree 2	Tree 3	Average
	lbs.	lbs.	lbs.	lbs.		lbs.	lbs.	lbs.	lbs.
1946					1947				
December ..	86				December	18	14	20	
1947					1948				
January ..	16	19	14		January	3	10	7	
February ..		71	21		April	37	41	54	
June ..		23	17		May	141	143	257	
October ..	115	4	1		June	11	11	82	
November .	24	5	28		July	98	76	52	
					August	150	79	104	
	241	122	81	148		458	374	576	469

Table II.

Girth, Height and Age Records of Rokam Masam Trees.

	Penang			Federal Experiment Station, Serdang.		
	Tree 1	Tree 2	Tree 3	Tree 1	Tree 2	Tree 3
Girth (inches)	18	17	18	25	26	25
Height (feet)	30	28	33	23½	25½	24
Age (years)	—	—	—	10	10	10

there exist varieties with sweet fruit." It appears that the variety at present in Malaya is not numbered among the latter.

PICKLE.

(i) *Jerok.*

To make this pickle, water is first boiled and salt is added. After cooling, fresh fruits are added together with a few crushed, fresh chillies and a little sugar. The amount of water used is just sufficient to cover the quantity of fruit to be pickled. The pickle can be used after three days.

(ii) *Achar.*

Fresh fruits are steeped in salted water for 2 days. The water is then poured off and the fruits are thoroughly dried, the drying process taking from 5 to 7 days. Small quantities of ginger, shallots, garlic and gingelly seeds are then fried in coconut oil, after which vinegar, mixed with one quarter of its volume of water, is added. Finally, after cooling, the dried rokam fruits are introduced to the mixture.

JELLY.

A very successful jelly has recently been made for which it is thought that a ready, though limited, market might be obtained since it can be used as a substitute for red currant jelly.

The fruit is simmered for about 15 minutes in water in the proportion of 1 pint of fruit to ½ pint of water. This mixture is then drained through a cloth and allowed to drip overnight. The resulting clear, red liquid is then brought to the boil as quickly as possible and sugar is added in the proportion of 1 lb. of sugar to 1 pint of liquid. This mixture is allowed to boil for about 10 minutes, after which it is poured into jars. If a sweeter jelly is preferred, 18 ozs. of sugar may be used or if, on the other hand, a slightly tart taste is desired 14 ozs. of sugar will be sufficient.

Two pints of fruit (weighing 1½ lbs.) gives 1 pint of liquid and rather less than 2 lbs. of jelly. Thus, with trees varying in annual fruit production from about 100 to 600 lbs, between 100 and 600 lbs. of jelly could be produced annually per tree. The figures in Table I leave little doubt that a production considerably higher than the lower figure can be expected from areas where the trees are regularly planted and are not in competition with other trees.

Summary.

Flacourtia inermis, a tree common in the Balik Pulau district of Penang but little known elsewhere in the peninsula, is described. The yields of trees in a Penang kampong and imported trees at the Federal Experiment Station, Serdang, have been recorded over a period of a year. The use of the fruit for making pickle and jelly is described.

Acknowledgements.

Acknowledgement is made to Mohd. Noordin bin Mohd. Kassim for the records of the Penang trees and particulars of the Malay pickles, to G. S. Keeping, Agricultural Officer (Research), for recording the yields of

trees at Serdang and to M. Z. Hartely for providing the particulars of jelly making.

References.

1. Burkill, I.H. "A Dictionary of the Economic Products of the Malay Peninsula". Governments of the Straits Settlements & F.M.S., 1935.
2. Ridley, H.N. "Fruits of the Malay Peninsula." *Agricultural Bulletin of the Straits & F.M.S.*, July, 1902.
3. Corner, E.J.N. "Wayside trees of Malaya." Government of the Straits Settlements, 1940.
4. MacMillan, H.F. "Tropical Gardening and Planting." Macmillan & Co. Ltd., London, 1948.
5. Ochse, J.J. "Fruits and Fruit culture in the Dutch East Indies."

MECHANIZATION.

Quarterly Progress Report, January to March, 1950.

Compiled by the Acting Senior Agricultural Officer (Research)

Recent Importations.

The following implements were received during the period under review:—

Ferguson Subsoiler.
Ferguson Disc-ridger.

Tests.

The Danuser Digger mounted on a Farmall 'H' tractor has successfully and cheaply made a number of planting holes at the Federal Experiment Stations, Serdang and Port Swettenham. Holes can be constructed up to 18 ins. in diameter and to 19 ins. in depth, and running costs vary from 3.65 cents per hole in light soil to 5.75 cents per hole in wet, heavy clay. The rate of working varied from 26 to 45 holes per hr. depending on soil conditions.

The tests on the Bristol '20' tractor were completed and a comparison of working costs using petrol and kerosene as fuel was made. Using a 2-furrow, direct-attached plough, the running cost per acre was $6.50 when using petrol and $5.65 when using kerosene.

Dynamometer tests made with the Field Marshall Mk. 1 tractor on pneumatic tyres, showed that the pull developed on a wet clay soil was reduced from 2,400 lbs. to 1,800 lbs. when a heavy growth of *Mimosa* was removed.

General.

Wet weather in the early part of the period under review held up work in most areas, but some progress was made during the latter half of February.

MECHANICAL OPERATIONS PREPARATORY TO PLANTING.

Coastal Clays.

The site of the experiment to be planted with Manila hemp at the Federal Experiment Station, Port Swettenham, was cleared and some chisselling was completed. Recent wet weather has, however, interfered with the holing of the area.

In the area on an estate in Selangor, from which the rubber had been removed, some drainage was necessary before heavy equipment could be safely worked and so a light Ransomes ditcher was drawn through the soil by a winch on an Allis Chalmers H.D.10 tractor. Due to the slow speed of the winch, the mould-boards did not scour properly and some of the spoil fell back into the ditches but, nevertheless, a considerable amount of water was removed.

Peat Soils.

An investigation to ascertain the number of trees and fallen timbers, and the pulls required to remove them continued at Chenderong Balai. This investigation should be completed by the middle of April.

'Muck' Soils.

An attempt was made to clear an area on an estate in Selangor on which some 3 to 12 ins. of peat overlies coastal clay. The mechanical operations proved to be much more difficult than was expected and work had to be postponed until conditions became dryer. After clearing this area, the object is to lay down an experiment into the drainage requirements and general cultivation methods required by these soils, of which a considerable area exists in Malaya.

Inland Soils.

Mechanical methods of terracing are being investigated at the Federal Experiment Station, Serdang, on slopes of hill quartzite soil with gradients varying from 1 in 7 to 1 in 3; the procedure adopted was to plough the upper half of the terrace with a Ransomes Shugadisc plough, to doze the loose soil downhill with a Caterpillar D.4 angledozer and then to complete the terrace with a Pacific Terracer drawn by a Standard Fordson tractor on Roadless half-tracks. This method proved to be satisfactory and although costing figures have not yet been completed the operations should be comparatively inexpensive.

Inter-row Cultivation.

Coconuts.

An experiment was laid down on an estate in Selangor to investigate the effect of drainage and depth of cultivation on yield of nuts.

Rubber.

A tractor and the necessary implements were lent to the Rubber Research Institute to lay down an experiment on their Experiment Station at Sungei Buloh. The experiment, which was laid down on a 'muck' soil overlying quartzite, consisted of four degrees of mechanical cultivation with 2 x 2 x 2 N.P.K. manures superimposed. Two experiments with similar layouts are being laid down on an estate on coastal clays in Selangor but no manurial treatments are being included. A similar one has been proposed for an estate on quartzite soil in South Johore.

NOTES ON CURRENT INVESTIGATIONS, JANUARY TO MARCH, 1950.

Compiled by the Acting Chief Research Officer and the Acting Senior Agricultural Officer (Research).

Padi.

The selection plots of Serendah Kuning and Nachin varieties were harvested and the records have been analysed. Environmental variation in all the plots has been too great for final selections to be made without further replicated plantings. Most of the variety trials of the past season have been reaped, and when the records are received it will be possible to analyse the combined results of a minimum experiment period of three years. The importance of an early (September maturing) padi season is of particular importance in some parts of Malaya, and in several States field experiments have recently been designed more precisely to discover the best varieties suitable for such "out-of-season" cultivation. An investigation to determine the effects of date of sowing on maturation periods on some of the more important varieties has been commenced in the padi experiment plot at Kuala Lumpur. An experiment to determine the degree of outcrossing is reported in this issue. It indicates that less than 1 per cent. of outcrossing occurred at Pulau Gadong, Malacca, in the last season.

The results of the last season's manurial experiments have not all been received. At Melor in Kelantan, in an observation trial with dry padi, mono-ammonium sulphate was applied during mechanical cultivation, either being ploughed in deeply, disc-harrowed into the surface soil, or in both these ways combined. There was unfortunately a carry over of manure into the control plots, so that although the observed increase in yield of grain was over 50 per cent., it is considered that it should have been nearer 100 per cent. There were no wide differences between the three manurial treatments, and the average yield was 1,700 lbs. per acre compared with a normal fair yield of 900 lbs. The yield of straw increased to almost the same extent. Chemical analyses of samples of the plants taken at the time of flowering, showed that those from the manured plots contained a greatly increased percentage of phosphate, whereas there were no important differences in the case of other nutrients. Ammonium phosphate was applied at the same rate to wet padi at Kota Bahru, Kelantan; but by the method of insertion by hand under the growing plant, application being made at different dates after transplanting, namely 1 to 2 weeks, 6 weeks and 10 weeks. Analyses of the plants at the time of flowering indicated that the heaviest growth resulted from manuring up to 6 weeks after transplanting. At harvesting, the plots manured at 6 weeks produced nearly twice as much straw as the controls. An increase in weight of grain of about 50 per cent. above the controls was experienced however on the plots manured both at 6 and 10 weeks. The early manuring gave a much smaller increase in grain yield.

No reports of padi blast (*Piricularia oryzae*) have been received during the last quarter. The commonest disease reported has been *Rhizoctonia* sheath rot. The experiments on the use of systemic and other insecticides against stem borers have so far given only a negative result.

Cocoa.

To investigate the possibility of more rapid clonal multiplication of cocoa, trials were made of the rooting of single leaf cuttings under continuous spray irrigation. Success in initiating rooting was followed by comparative failure in the matter of survival rate, but experience was gained. The leaf base should not be buried, the leaf should be held clear of the soil, the stem fixed firmly in the rooting material and its upper, cut end protected from fungal infection. Under light shade, with protection from wind and heavy rain, a fine even spray is desirable and may be intermittent. A fairly large mature leaf and stem, given hormone treatment, is most satisfactory.

Experiments on methods of establishment are continuing. Although the raising of seedlings in baskets is the normal practice, raising them in nursery beds and subsequent transfer to the field is being investigated. Seed sown at stake germinated well but subsequent growth was poor. It is confirmed that maximum growth is obtained when seedlings are grown in the field with a side shade of palm fronds. Very healthy plants are being grown under fairly high jungle shade.

Plans to investigate the growing of cocoa interplanted with other crops have been made and circulated to interested persons with the object of finding sites to put them into practice. Variety trials are being made with local Trinitario and imported West African cocoa. Further determinations of compatibility among Trinitario trees, grown by the Department, have been made and breeding has continued. Seed from selected local material of Criollo type, found in various parts of the country, is being planted in order to establish a block of this type for further selection and breeding. The importation of West African seed under stringent precautions against the introduction of disease was successfully accomplished, and the seedlings, after being raised in isolation on Pulau Tekong, Singapore, are being distributed.

Experiments on the small-scale fermentation of Trinitario and Criollo beans have been made; and it is clear that the establishment of a standard treatment for a small amount of seed of either type must be very difficult because of the wide variation in samples of beans and their pulp, resulting in great differences in behaviour.

Oil Palms.

Breeding amongst selected palms has continued. Seedling palms grown in nutrient solutions, alike except for acidity, in a series at pH 3.5, 4.5, 5.5 and 6.5, thrived best in the most acid solution. In the two least acid solutions the seedlings developed unhealthy symptoms. The phosphoric acid content was highest in the plants in the most acid solution, and these plants also contained a higher proportion of potash in the ash and less calcium and magnesium than the others. A manurial experiment on the effect of phosphate, potash and magnesium has been laid down on an estate.

Tea.

In continuation of the tea selection programme and in preparation for vegetative propagation trials, 580 tea bushes at the Federal Experiment Station, Serdang, which had previously been selected, were pruned in order to obtain a young growth for cuttings.

Fodder Grass.

Four separate trials are in progress at Serdang; a variety trial with fertilisers and with farmyard manure, a factorial NPK experiment at three levels, a trial of increasingly heavy nitrogen dressings, and a trial of frequency of application of fertilisers. Preliminary results show no significant differences in respect of frequency of application. In the 3 x 3 x 3 manurial trial, there were significant responses to nitrogen and potash, and an insignificant depression due to phosphate. In the experiment with heavy dressings of nitrogen, an early effect observed was that with increasing rate of application, the crude protein content of Guinea grass increased very considerably and then diminished a little.

Pasture.

The pasture establishment experiment, commenced in 1948, has been concluded, and all the data are being analysed. The field was formerly under lalang which was eradicated mechanically before pasture grasses were established by different methods on different plots and subsequently subjected to such after-treatments as weeding, mowing and grazing. The whole field is now being grazed and mowed.

Other experiments in progress include the growth of pasture under shade trees and fruit trees, the eradication of lalang by grazing, comparison of various grasses, establishment by discing-in of planting material, and an investigation to find the area necessary to support bullocks.

Maize.

A variety trial was completed which gave very satisfactory yields per acre, and showed hybrids of the varieties Burma White and local to be significantly better than those of Burma Yellow. The highest yield was at the rate of nearly 24 cwts. per acre.

Potatoes.

At Cameron Highlands, gardeners are accustomed to plant, as seed, the imported Australian potatoes sold in the local shops, and the crops frequently suffer severely from blight. Nine blight resistent varieties of potatoes were imported from Holland, and produced crops as good or much better than the locally purchased Australian seed. Subsequently, seed saved from the crops was planted in a severe blight resistance trial, in which two varieties were highly resistant, three were susceptible and the remainder fairly resistant. Growth, however, was extremely weak and there was no crop, showing that locally grown seed is useless, and that fresh seed would have to be imported for every crop. One of the highly resistant varieties, named Voran, was also the best yielder in the first planting, yielding at the rate of 18,600 lbs. per acre.

Soils.

The soil survey of the Trans-Perak padi irrigation scheme has continued. Soils near the west bank of the Perak River consist of alluvial clay, but further westwards there is peat and muck extending in places to 10 ft. in depth. Often the peat or muck is covered by a surface deposit of up to 1 ft. of silt. A preliminary survey was made on a proposed irrigation area at Pasir Akar, near Besut, Trengganu. An area of Trengganu along the Jerangau road was surveyed as potential cocoa land. It appeared that the soil was derived in part from coarse-grained as well as fine-grained granite, and that in depressions between the ridges sandy swamps prevailed.

The study of peat soils is continuing. The pots of peat in which a padi manurial experiment had already been conducted were replanted with padi without further manuring, except that the padi straw and the surface peat were burnt off. Initial growth in the previously manured plots was good, but after a short time the plants were stunted, with yellowing leaves as if due to nitrogen starvation.

Canning Research.

Further trials of canning local foodstuffs at the Canning Research Station, Johore Bahru, have been successfully made.

Abstract.

DIFFICULTIES IN MANGOSTEEN CULTURE*.

Introduction.

The fruit of the mangosteen, *Garcinia mangostana* L., has been extolled by practically everyone who has written on the subject. Its flavour is destroyed in canning but an agreeable preserve can be made by boiling with sugar. The inclusion of the seeds adds a nutty flavour.

The seeds are edible when cooked. The rind is valuable as an excellent tanning agent, and has proved useful, when sliced and dried, as a remedy for dysentery, chronic diarrhoea, and cystitis. The heavy, dark brown, durable wood barely floats in water. It is useful in woodwork and building construction but limited by relatively small dimensions.

The mangosteen originated in the East Indies although its natural range has not been well defined. Cultivation is now established throughout the East Indies, southern Philippines, Burma, Malaya, Cochin China, Siam, south eastern India, and Ceylon. Occasional trees as well as a few orchards are found in the West Indies and continental tropical America. The many attempts to establish plantings in a cooler climate such as the northern Philippines, China, Australia, and Florida have generally failed. It is confined to lower elevations with 1,500 ft. being about the maximum. Superior growth is obtained near sea level.

A high, well-distributed rainfall appears necessary for successful culture. Even in Burma where precipitation reaches 200 ins., irrigation is necessary for good crops during the dry season. On the island of Dominica, B.W.I., mangosteens receiving 80 ins. a year required great care to grow at all but thrived at another location with 105 ins. in a more retentive soil. Several authors have pointed out the superiority of plants growing under irrigation. A soil in which the water table is maintained within 6 ft. of the surface is considered very desirable. The importance of this condition is evidenced by the successful growth of mangosteens in close proximity to streams, lakes, or other bodies of fresh water.

Drainage is necessary, particularly with young plants, although plantings have been made in the Canal Zone on soil too wet for other fruit tree crops during the entire rainy season, and an orchard has been established in a swamp, with full drainage ditches between the rows, and another where the orchard was almost constantly under fresh running water. Most of the failures with mangosteen plantings in Puerto Rico probably can be attributed either to an excess or deficiency of water; the latter frequently occurring during the 3 to 6 months dry season.

The trees grow well in clay or sandy loam; the chief soil requirement appears to be a high organic matter content.

---

*Abstract of an article with this title by Edward P. Hume, Horticulturist, Federal Experiment Station, U.S. Department of Agriculture, Mayaguez, Puerto Rico. *Tropical Agriculture*, Vol. XXIV, Nos. 1-3, January to March. 1947.

Some wind protection is highly desirable for a mangosteen planting. Hot moist valleys or other protection from drying winds or gales is necessary for good production. In Jamaica the trees were found intolerant of the sea breezes which presumably carried salt.

Mangosteen Culture.

Seed. Early distribution of the mangosteen throughout its geographically adapted range apparently was prevented because of the short viability of the seed. If the seeds are left in the fruit they retain viability for 3 to 5 weeks but when removed they last only a few days unless protected against drying. The best method to ship seed is in sealed cans containing very slightly damped charcoal. It is obvious that seed should be planted as soon as possible. In Trinidad much better growth has been recorded from seed obtained from Singapore than with locally-grown seed. At Mayaguez, superior plants have been obtained in recent years from seed secured from the Canal Zone over that locally produced. Both Malaysia and the Canal Zone appear somewhat better suited for mangosteen culture than most islands of the West Indies.

Seed Germination and Seedling Development. Work on the nature of the mangosteen seed has shown that it is not a true seed in a botanical sense but a hypocotyl-tubercle, or a primitive adventitious embryo originating from a cell of the ovary inner wall; it is simply a tuberous stem from which the new plant develops. It is never fertilised and thus represents a special form of vegetative reproduction. The striking uniformity among mangosteen trees has been shown to be the result of this asexual propagation. Germination begins with the development of two swellings at opposite sides of the "seed"; the first root arises from one swelling while the shoot develops from the other. Later a new root system develops from the base of the shoot and the original root system usually ceases to function. Better germination, survival, and subsequent early growth can be obtained from large seeds. The use of seeds weighing over 1 gram is recommended.

The media for germinating should be high in organic matter, but well drained. A mixture of leaf-mould, sand and charcoal has been recommended and suggests a rich soil with ample leaf mould, while Gregson recommends 5 parts top soil and 3 parts burnt soil. The method of handling is quite variable. In the plantation at Tela, Honduras, and also at the Canal Zone Experiment Gardens the seeds are germinated in pots and transplanted at the 2-leaf stage to deeply prepared nursery-beds supplied with plenty of organic matter. Plants are spaced 12 to 15 ins. until they are 2 ft. high, when they are transplanted to a permanent location. In Burma a recommended alternative is to plant the seed in pots 1 to 1½ ft. deep where they remain until ready for planting in the orchard. Both methods overcome to a great extent one of the most serious cultural problems during the early growth period. At this stage seedlings often cease growing, turn yellow, and the leaves develop dead areas. Plants in this condition rarely, if ever, recover. The mangosteen tap root is very long, delicate, and easily damaged by contact with the bottom of a pot, with a consequent serious checking

of growth. Furthermore, the lateral roots of a seedling are normally formed at a depth considerably below the bottom of the usual sized pot. At Tela, Honduras the majority of lateral roots were found at a depth of 4 to 10 ins. This deep-rooted nature of the plant also presents difficulty at the time of transplanting. The trouble is so serious that one writer recommends direct seeding in the permanent location, and most authors recommend permanent planting before the plants exceed 2 ft. in height. At this stage the root system may be deeper than the top is tall. Plants from nursery-beds must be moved with a deep ball of earth; and those growing in bamboo pots should have the pots split carefully to avoid root damage.

Early Death and Slow Growth in Seedling Stage. One investigator has shown that early growth can be stimulated by frequently supplying an extract of Brewer's yeast.

Many efforts have been made to overcome the weak root system of the young plants. Propagation by cuttings has been reported as follows: "Increase is effected by ripened cuttings which root readily in sand under a hand glass in heat". It has also been reported that cuttings have been tried in Trinidad with a fair degree of success. This method appears to be the most practical if a high percentage can be rooted. Budding is reported as successful if the two horizontal cuts are made 6 days earlier to avoid fermentation. Grafting can be accomplished in so far as union of the stock and scion is concerned but the later results have generally been unsuccessful. An investigator succeeded in uniting mangosteen scions on twenty other *Garcinia* stocks by inarching on mature mangosteen trees. The new plant is formed by gradually cutting below the union on the mangosteen and removing the top of the stock. All of these grafts, as well as those on species of *Calophyllum* and *Platonia* were not satisfactory because of incompatibility or different growth rates. In several instances the scions developed roots and established themselves but the stocks eventually died. A more successful method was to established a mangosteen seedling in the same pot with a *G. tinctoria* plant and inarch them. Unhealthy seedlings were revitalised and made better growth on their own roots as a result of contact with the nurse plant.

Considerable time and effort has been expended all over the tropical world to find a suitable stock for the mangosteen. One investigator claims the Bumag, an unidentified *Garcinia*, which is a native of the Sulu Archipelago and southern Philippine Islands, has served as a successful stock for at least 5 years. He reports it to be a vigorous grower and capable of resisting considerable drought. He also recommended trying other species of *Garcinia* with termineral inflorescence and especially with a hard pericarp which would be closely related and consequently more likely to be compatible. Another investigator recommends propagation from suckers or basal sprouts.

Water Relations. Water supply appears to be extremely important, particularly in the early stages of development. The root system in addition to being notoriously weak is devoid of root hairs both in seedling and mature state as observed at Mayaguez. Plants with root hairs have an

advantage because their roots are in contact with a much larger volume of soil from which to obtain water. At Mayaguez, especially built nursery-beds with moderate shade (400 to 1,800 foot-candles) apparently failed to develop healthy plants because of inadequate water supply during the dry season. On the other hand, the young plants need good drainage. In the seedling stages standing water over the roots kills them quickly. At Mayaguez, plants in forest nursery-beds with about as much shade as nearby vigorous plants were receiving, but where adequate drainage was not provided, were dead within a year after planting.

Shade. There is some question as to how long or how much shade is necessary for the young plants. In the Canal Zone a light shade for seedling plants and nursery-beds was adequate, while it has been stated that heavy shade is necessary in the nursery-beds. The orchard area should be preplanted to shade trees which can be thinned out gradually. It appears that some shading at least is beneficial during the first 4 to 5 years. At Mayaguez, plants in nursery-beds with insufficient shade, where the leaves were exposed to direct sun (generally 8,000 to 12,000 foot-candles) for an hour or more daily, have been completely eliminated while those under dense shade (80 to 400 ft.-c.) have made very little growth. A partial, but evenly distributed shade, except on the north side, has given the best results in the nursery-beds. Satisfactory growth of mangosteen seedlings was obtained in plots receiving 400 to 1,300 ft.-c. on an "average" day.

Fertilisation. The occasional application of liquid manure to seedlings is beneficial according to another investigator. In a single experiment at Mayaguez neither manure mixed with a peat substrate nor a 6-8-9 chemical fertiliser mixed with the substrate, nor on the surface 6 months later gave beneficial results. Dilute organic fertilisers which can be absorbed slowly are perhaps desirable, but the mangosteen is apparently not capable of utilizing strong concentrations of nutrients. Soils with high organic matter content are apparently beneficial as a source of nutrients.

Orchard Problems.

Time of Bearing. The mangosteen comes into bearing relatively slowly. The shortest time recorded is 8 to 9 years from planting in Ceylon, and other authors report from 10 to 20 years. The two oldest trees at Mayaguez required 20 years to produce the first fruits. Bearing is irregular, occasionally a light second crop is obtained in the same year, but once in a while an entire year is skipped. Vigorous bearing trees may yield 500 to 1,500 fruits most years for many years. Growers are hesitant to plant mangosteen orchards because of the long time required before there can be any possible returns on their investment. This difficulty can partially be alleviated by inter-cropping with shorter cycle crops as pineapple, arrow-root, ginger and pepper. They not only help defray the cost of establishing the orchard but also supply tillage and fertilisers for the mangosteen trees.

Pruning. Little or no pruning is practised commercially. The only pruning recommended is the removal of the dead and diseased wood, the upright growing suckers, and any excessive weak, interior branches.

Departmental Notes.

Appointment.

The Right Honourable the Secretary of State for the Colonies has been pleased to approve the appointment of Mr. O. J. Voelcker, C.B.E., as Director of Agriculture, Federation of Malaya, with effect from 13th January, 1950. Mr. Voelcker arrived in Malaya on the 5th February, 1950.

Retirement of Raja Mahmud bin Raja Ali.

Raja Mahmud bin Raja Ali, Malay Agricultural Officer, East Pahang, left the Department on retirement on 24th March, 1949, after nearly 36 years service.

Raja Mahmud originally served with the Forest Department, which he joined in 1911. He was sent to India in 1912 for training in forestry at Dehra Dun and returned to Malaya at the end of 1913. He left the Forest Department owing to ill-health shortly afterwards and joined the Department of Agriculture as a Malay Apprentice in November, 1914. He became an Agricultural Assistant in 1918 and was promoted to the Special Grade post of Malay Agricultural Officer in 1932.

Apart from a spell in Kedah from 1922-24, when he laid the foundations for the work of the Department there, Raja Mahmud has largely been identified with the College of Agriculture, and earlier the Agricultural School, and with the State of Pahang. He served in the Agricultural Education Branch from 1925 to 1932 and was Junior Lecturer at the College of Agriculture from January, 1931, until his transfer to Pahang in August, 1932. Thereafter, apart from a brief interlude in Negri Sembilan and at Headquarters during 1946-47, the whole of his service was spent in Pahang. He twice acted as State Agricultural Officer, in 1934 and again in 1948-49. During his final spell of service, he was a member both of the State Executive Council and of the Council of State. On 24th May, 1949, he was appointed a Temporary Unofficial Member of the Federal Legislative Council.

During his long service with the Department, Raja Mahmud acquired a wide knowledge of the small-holding agriculture of the country and this, coupled with his close contact with, and deep understanding of the small-holder and his problems, was of the utmost value to the Department. In addition, his quiet dignity, courteous manner and readiness to place his knowledge at the disposal of others earned for him the highest esteem of his colleagues. He was a fine type of Malay officer and his retirement leaves a big gap. Members of the Department and others who worked with him will join in wishing him a long and happy retirement.

R. G. H.

Leave.

Mr. R. G. Heath, Chief Field Officer, has been granted 180 days leave, in addition to voyages, with effect from 28th March, 1950.

Mr. R. J. A. W. Lever, Entomologist, has been granted 180 days leave, in addition to voyages, with effect from 26th January, 1950.

Mr. L. N. H. Larter, Botanist, has been granted 139 days leave, in addition to voyages, with effect from 28th March, 1950.

Mr. A. Johnston, Plant Pathologist, has been granted 170 days leave, in addition to voyages, with effect from 24th March, 1950.

Mr. H. D. Meads, Personal Assistant to the Director of Agriculture, has been granted 128 days leave, in addition to voyages, with effect from 28th March, 1950. Mr. H. F. Logan, Personal Assistant to the Chief Field Officer, is acting as Personal Assistant to the Director of Agriculture.

Transfers.

Mr. J. L. Greig, Senior Agricultural Officer, State Agricultural Officer, Johore, has been transferred to Headquarters with effect from 26th March, 1950, to act as Chief Field Officer and Agricultural Economist.

Mr. R. Henderson, Agricultural Officer, Johore Central, has assumed duty as Acting State Agricultural Officer, Johore, with effect from 27th March, 1950.

Mr. J. Chattaway, Agricultural Officer, has been transferred from the Federal Experiment Station, Serdang, and assumed duty as Agricultural Officer, Johore Central, with effect from 7th April, 1950.

Relinquishment of Duty.

Mr. H. L. Barnett, Registrar of Statistics, Federation of Malaya, and Acting Agricultural Economist, relinquished duty as Acting Agricultural Economist, with effect from 1st March, 1950.

Resignation.

Mrs. M. Johnston, Temporary Botanist, resigned with effect from 17th April, 1950.

Statistical

MARKET PRICES

January to March, 1950.

Rubber.—The Singapore price of No. 1 R.S.S., f.o.b., in bales, continued to increase during the first quarter of 1950, the price at the end of March being very nearly 7 cents per lb. higher than it was at the end of 1949.

The year started with the price at 50½ cents per lb. but by the 16th of January it had fallen to 49 cents. A gradual increase brought the price to 51⅛ cents on the last day of the month, giving an average for the month of 50 cents. The average price for February was 52.86 cents per lb., the month having opened with the price at 51 cents and gradually increasing to close at 53⅛ cents. After dropping from 53¾ cents on the 7th March to 52⅜ cents on the 13th, the price increased to 57 cents on the last day of the month, making the average for March 53.83 cents per lb.

The average prices paid for smallholders' rubber at three centres in the Federation of Malaya during the first quarter of 1950, are given in Table I.

Table I.

Average Monthly Prices Paid by Local Dealers for Smallholders' Rubber, January to March, 1950.

(Dollars per picul of 133⅓ lbs.)

Grades	Taiping, Perak.			Seremban, Negri Sembilan.			Batu Pahat, Johore.		
	Jan.	Feb.	Mar.	Jan.	Feb.	Mar.	Jan.	Feb.	Mar.
Smoked Sheet ..	61.50	64.50	65.00	61.35	65.85	66.65	56.85	60.69	61.00
Unsmoked Sheet ..	54.50	58.50	57.50	54.50	59.00	58.00	52.14	54.48	55.00
Scrap ..	21.00	24.50	32.50	28.00	34.00	35.50	16.94	18.60	18.00

Transport from Batu Pahat to Singapore by lorry, excluding duty, 80 cents per picul.

Tea.—The average price paid in Colombo for Malayan tea, as quoted in the Colombo Brokers' Association weekly report dated 28th March, 1950, was Rs.1.63 per lb. The average prices of Ceylon teas were as follows, in rupees per lb.: High Grown Teas Rs.2.46, Medium Grown Teas Rs.1.92, Low Grown Teas Rs.1.78.

Ceylon Teas are subject to an export duty but non-Ceylon teas sold at auctions ex-bond in Colombo for re-export are not subject to this duty.

The retail price for Malayan tea (Boh) has increased to $2.25 per lb.

Palm Oil.—The price paid to producers by the United Kingdom Ministry of Food, who continue to purchase the majority of Malayan estate production, is now £74 per ton f.o.b. Singapore. The 5 per cent. *ad valorem* Malayan export duty is for sellers' account.

Derris.—The Singapore Chamber of Commerce weekly reports have shown little variation in the price of this commodity. During the first quarter of the year the price has varied between $80 and $85 per picul.

Tobacco.—The average prices paid per picul for cured leaf in Kelantan during the first quarter of 1950 were as follows:—1st quality $400, 2nd quality $235 and 3rd quality $180.

Rice.—There was no change in the controlled price or in the ration of rice during the first quarter of the year. The weekly ration per person is 3½ katis and the controlled price $26 per picul.

Table II.

Singapore Prices of Various Agricultural Products.

(Dollars per picul)

Date	Copra, Sundried	Coconut oil *	Pepper. F.A.Q. Muntok white	Pepper. Gen. Muntok white	Gambier. Cube	Sago Flour. Lingga	Tapioca Flour No. 1	Oilcake. Round
1950								
3rd Jan.	34.50	58.50	830.00	840.00	48.50	13.75	16.50	15.50
9th Jan.	34.75	59.00	775 00	785.00	49.00	13.75	16.50	16.50
16th Jan.	36.00	58.50	790.00	800.00	50.00	13.75	16.50	16.50
23rd Jan.	36.00	59.00	850.00	860.00	51.00	13.75	17.00	17.50
30th Jan.	36.00	59.00	830.00	840.00	51.00†	13.75	16.50	18.50
6th Feb.	36.00	59.00	850.00	860 00	51.00	13.75	16.25	15.50
13th Feb.	36.50	59.50	870.00	880.00	51.00	13.75	16.25	15.50
20th Feb.	37.00	59.50	890.00	900.00	51.00	14.00	16.25	15.50
27th Feb.	36.50	60.00	900.00	910.00	58.00†	14.25	16.50	15.50
6th Mar.	36.50	61.00†	880 00	890.00	60.00	14.25	16.50	14.50
13th Mar.	37.25	62.00	890.00	900.00	60.00†	14.25	16.50	14.00
20th Mar.	36.75	62.50	870.00	880.00	60.00†	14.25	16.50	14.50
27th Mar.	37.00	63.00	870.00	880.00	60.00†	14.25	16.50	15.00

* F.O.B. † Nominal

The above prices are taken from the weekly report of the Singapore Chamber of Commerce.

FEDERATION OF MALAYA

PRODUCTION OF PALM OIL AND KERNELS.

(In long tons as declared by Estates)

Month	Palm Oil		Palm Kernels	
	1949	1950	1949	1950
January ..	3,793.0	3,958.5	799.9	896.0
February ..	4,007.0	3,643.1	821.4	969.9
March ..	4,055.6	4,860.6	860.1	1,184.0
April ..	3,999.3		808.3	
May ..	4,120.9		809.2	
June ..	4,321.5		791.2	
July ..	4,461.3		931.0	
August ..	4,398.2		906.0	
September ..	4,234.9		858.9	
October ..	4,125.5		875.3	
November ..	4,504.3		994.1	
December ..	4,539.2		1,004.0	
Total ..	50,560.7	(12,462.2)	10,459.4	(3,049.9)

In December 47 estates (planted area 87,741 acres) were in production out of a total of 54 oil palm estates (planted area 90,707 acres).

MALAYAN AGRICULTURAL EXPORTS, OCTOBER-DECEMBER, 1949.

Product	Net Exports in Tons.			
	Year 1947	Year 1948	Oct.-Dec. 1948	Oct.-Dec. 1949
Arecanuts	12,507	6,043	3,111	988
Coconuts fresh†‡ ..	62,873†	44,887†	10,957†	5,490†
Coconut oil‡	41,112	45,245	13,750	12,574
Copra‡	45,439*	28,625*	586*	7,111*
Copra cake	5,260*	12,176*	4,428*	5,656*
Gambier, all kinds ..	1,156	286	33	56
Palm kernels	5,245	6,462	1,838	2,633
Palm Oil	43,325	46,821	12,348	12,570
Pineapples, canned ..	2,611	4,073	450	8,137
Rubber¶	645,229¶	696,978¶	170,324¶	173,685¶
Sago,—flour	5,958	16,946*	4,964*	2,247
„ —pearl	2,404	19,084	6,683	393
„ —raw	6,415*	6,667*	3,352*	139*
Tapioca,—flake	52	304	94	204
„ —flour	6,490	1,999*	645*	491*
„ —pearl	7,205	14,263	3,901	4,200
Derris	243	80	6	6
‡Copra equivalent ..	22,625	45,795	21,977	13,432

¶ production (Federation of Malaya). † hundreds in number. * net imports.

FEDERATION OF MALAYA RUBBER PRODUCTION.

(In long tons, dry weight)

Month	Estates		Smallholdings (Estimated)		Total	
	1949	1950	1949	1950	1949	1950
January ..	36,397	35,237	24,052	26,440	60,449	61,677
February ..	27,593	27,297	17,450	22,645	45,043	49,942
March ..	33,616	27,789	20,309 14,113†	21,688 476†	53,925 14,113†	49,477 476†
April ..	28,142		16,744		44,886	
May ..	33,570		18,499		52,069	
June ..	32,921		18,683 2,705†		51,604 2,705†	
July ..	35,751		20,137		55,888	
August ..	36,658		20,504		57,162	
September ..	33,828		24,900*		58,728*	
October ..	30,788		20,096		50,884	
November ..	35,169		23,825		58,994	
December ..	35,576		23,977 4,254†		59,553 4,254†	
Total ..	400,009	(90,323)	270,248	(71,249)	670,257	(161,572)
Total 1948 ..	402,907		294,071		696,978	

Small-holding production is estimated from purchases reported by dealers.

† Quarterly adjustment.

* Includes quarterly adjustment (deduction of 822 tons).

FEDERATION OF MALAYA

PRODUCTION OF COPRA, COCONUT OIL AND COPRA CAKE.

(in tons)

Month	Copra Production						Coconut Oil Production		Copra Cake (Poonac) Manufactured	
	Estates		Small-holdings (estimated)		Total		Oil Mills		Oil Mills	
	1949	1950	1949	1950	1949	1950	1949	1950	1949	1950
January ..	2,476	2,577	7,406	6,415	9,882	8,992	4,727	5,501	3,245	3,634
February ..	2,605	2,662	5,544	5,818	8,149	8,480	4,429	4,831	3,027	3,182
March ..	2,644	3,064	4,981	6,712	7,625	9,776	4,638	5,774	3,211	3,798
April ..	2,755		6,203		8,958		4,832		3,325	
May ..	3,039		5,884		8,923		4,995		3,437	
June ..	3,500		6,723		10,223		5,607		3,756	
July ..	3,838		6,915		10,753		5,710		3,870	
August ..	3,867		8,676		12,543		5,671		3,858	
September ..	3,651		9,256		12,907		6,282		4,190	
October ..	2,778		7,745		10,523		5,440		3,711	
November ..	3,035		9,332		12,367		5,736		3,871	
December ..	2,769		7,315		10,084		5,631		3,799	
Total ..	36,957	(8,303)	85,980	(18,945)	122,937	(27,248)	63,698	(16,106)	43,300	(10,614)

Notes:—1. The above statistics are compiled and published by the Registrar of Statistics, Federation of Malaya.

2. Estate copra production and coconut oil production are as declared by estates and oil mills respectively.

3. Statistics of small-holding coconut oil production are not available.

4. Small-holding copra production for commercial purposes is estimated from the formula: imports + estate stocks (opening) + estate production + small-holding production = exports + local oil mill consumption + estate stocks (closing).

METEOROLOGICAL SUMMARY, MALAYA, JANUARY, 1950.

Locality	Air Temperature degrees Fahrenheit							Earth Temperature		Rainfall									Bright Sunshine		
	Means of			Absolute Extremes									Number of days								
	A. Max.	B. Min.	Means of A and B	Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	At 1 foot °F	At 4 feet °F	Total		Most in a day Amt.	Precipitation .01 in or more	Precipitation .04 in or more	Thunderstorm	Fog morning obs.	Gale force 8 or more	Total	Daily Mean	Per cent.
										ins.	m.m.	ins.						hrs.	hrs.	
Ipoh, Perak ..	90.9	71.3	81.1	94	69	87	73			9.69	246.1	1.90	13	12	6			200.55	6.47	
Port Swettenham, Selangor	87.7	72.2	79.9	92	69	81	75	84.5	84.6	3.78	96.0	1.13	16	12	2			167.15	5.39	
K. Lumpur, Selangor ..	88.8	72.6	80.7	92	70	80	75			12.50	317.5	2.09	21	19	8	4				
Sitiawan, Perak ..	88.3	71.8	80.1	91	69	84	74	83.9		2.73	69.3	1.07	13	9	5	1		189.40	6.11	
Kuala Lipis, Pahang ..	86.1	71.0	78.5	90	69	80	73	82.0	82.2	17.40	442.0	3.26	24	21	3	22		158.40	5.11	
Kuantan, Pahang ..	86.3	70.8	78.5	90	68	77	73			14.39	365.5	6.47	19	16		4		165.30	5.33	
Temerloh, Pahang ..		72.9			71		76			9.79	248.7	2.60	21	17		1		171.80	5.54	
Bayan Lepas, Penang ..	87.8	73.5	80.7	91	71	82	76			3.45	87.6	0.93	10	9	1			230.25	7.43	
Malacca ..	86.7	73.5	80.1	91	72	79	76			4.77	113.5	1.34	14	12						
Mersing, Johore ..	82.7	73.1	77.9	86	69	76	78			14.10	358.1	3.17	23	18	2		1	186.20	6.01	
Alor Star, Kedah ..	89.4	70.9	80.1	93	66	83	74			1.39	35.3	0.90	9	4						
Kota Bharu, Kelantan ..	84.7	73.5	79.1	87	71	80	76	82.5		7.04	178.8	1.57	22	14	1	4		209.10	6.75	
K. Trengganu, Trengganu		72.8			71		76			6.70	170.2	1.61	20	18	1	2	1	199.00	6.42	
HILL STATIONS.																				
Fraser's Hill, Pahang 4268 ft. ..	70.8	61.1	65.9	78	58	64	63	70.6		8.23	209.0	2.15	25	21		22		126.05	4.07	
Cameron Highlands, Tanah Rata, Pahang 4750 ft.	71.7	55.0	63.3	75	50	67	60	66.7	67.7	9.70	246.4	1.93	10	8				126.50	4.08	

Compiled from Returns supplied by the Malayan Meteorological Service.

METEOROLOGICAL SUMMARY, MALAYA, FEBRUARY, 1950.

Locality	Air Temperature degrees Fahrenheit							Earth Temperature		Rainfall								Bright Sunshine		
	Means of			Absolute Extremes									Number of days							
	A. Max.	B. Min.	Means of A and B	Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	At 1 foot °F	At 4 feet °F	Total	Most in a day Amt.	Precipitation .01 in or more	Precipitation .04 in or more	Thunderstorm	Fog morning obs.	Gale force 8 or more	Total	Daily Mean	Per cent.
										ins.	m.m.	ins.						hrs.	hrs.	
Ipoh, Perak ..	92.3	72.1	82.2	96	68	82	75			3.32	84.3	1.03	10	9				197.90	7.07	
Port Swettenham, Selangor	90.1	71.7	80.9	93	68	81	74	85.8	85.1	3.90	99.1	1.15	11	7	2			188.95	6.75	
K. Lumpur, Selangor ..	90.8	72.7	81.7	95	68	80	75			1.68	42.7	0.63	12	9	8	3				
Sitiawan, Perak ..	89.6	72.4	81.0	92	71	84	75	84.8		3.94	100.1	1.40	9	6	1			192.15	6.86	
Kuala Lipis, Pahang ..	87.0	71.1	79.1	94	68	74	75	82.9	82.9	8.27	210.1	3.24	11	10	1	14		167.60	5.99	
Kuantan, Pahang ..	86.4	70.2	78.3	92	66	74	73			24.26	616.2	8.53	14	12		9		164.45	5.87	
Temerloh, Pahang ..		72.5			69		75			11.93	303.0	4.76	15	14		9		178.40	6.37	
Bayan Lepas, Penang .	88.6	73.6	81.1	92	71	83	76			2.16	54.9	0.43	12	12	6			218.50	7.80	
Malacca ..	87.4	73.2	80.3	91	70	78	76			2.50	63.5	1.06	8	6	1			197.95	7.07	
Mersing, Johore ..	84.0	72.3	78.7	87	69	79	78			6.19	157.2	2.24	11	19				182.00	6.50	
Alor Star, Kedah ..	90.9	71.6	81.3	95	69	82	76			4.44	112.8	1.10	12	8	2			217.90	7.78	
Kota Bharu, Kelantan ..	85.9	72.9	79.4	88	69	81	77	83.2		10.51	267.0	5.19	11	9				208.05	7.43	
K. Trengganu, Trengganu		72.0			69		75			7.15	181.6	2.14	13	11			2	185.20	6.61	
HILL STATIONS.																				
Fraser's Hill, Pahang 4268 ft. ..	72.9	61.4	67.1	79	59	62	64	71.5		11.94	303.3	5.62	17	15	1	13		160.35	5.73	
Cameron Highlands, Tanah Rata, Pahang 4750 ft.	63.4	53.8	58.6	78	47	66	61	66.8	68.2	7.49	190.2	1.99	17	11				146.60	5.23	

Compiled from Returns supplied by the Malayan Meteorological Service.